Investing in the Future of Jobs and Skills

Scenarios, implications and options in anticipation of future skills and knowledge needs

Sector Report
Non-Metallic Materials

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Preface

This report presents the final results of the study *Comprehensive analysis of emerging competences and economic activities in the European Union in the Non-Metallic Materials sector*. The report is part of a series of sixteen future-oriented sector studies on innovation, skills and jobs under the same heading, commissioned by the European Commission (DG Employment, Social Affairs and Equal Opportunities). Eleven of these studies were executed by a core consortium led by TNO (Netherlands Organization for Applied Scientific Research) and consisting of TNO Innovation Policy group (Leiden, the Netherlands), TNO Labour (Hoofddorp, the Netherlands), TNO Innovation and Environment (Delft, the Netherlands, SEOR Erasmus University (Rotterdam, the Netherlands) and ZSI (Centre for Social Innovation, Vienna, Austria). The core consortium was in charge of the overall management of the study, the further elaboration and application of the overall approach and methodology, as well as data collection and analysis.

The study was carried out during the period January 2008-April 2009. Stakeholders in the sector, including the European sectoral partners and representatives of various other organisations, have been involved in various ways and forms throughout the study. This included a sectoral kick-off meeting at the start of the study and three multisectoral stakeholder meetings in Brussels during which intermediate results of the studies were presented and discussed. Valuable workshop discussions in the frame of the project were held and inputs received from a number of experts, of which especially Marc Bolech (TNO Materials Performance, the Netherlands) should be mentioned.

A draft final version of this report was validated and complemented during a second external, final workshop in Brussels on 6 and 7 November 2008. The final workshop brought together an apt mixture of different European and national sector experts representing the industry, European social partners, other various representative organizations, academia as well as the European Commission (see Annex 2 for a full list of participants). The workshop, which formed an explicit and integral part of the methodological approach, yielded a number of helpful comments and insights which have been used in further finalising the study. We express our sincere gratitude to all workshop participants and to all those that contributed to this study, in particular Dr Wyart-Remy, Mr Chruszczow, Dr Stournaras, Mr Pereda, Mr Swiatek, Prof Siores and Mr Macak.

A special word of thanks holds for the European Commission, notably Jean-François Lebrun and Manuel Hubert, and Radek Owczarzak of the European Foundation for the Improvement of Living and Working Conditions who proved to be excellent guides during the project.

Delft, May 2009
Dr Frans A. van der Zee (overall project leader)

1 General introduction

This report presents the final results of the study *Comprehensive analysis of emerging competences and economic activities in the European Union in the non-metallic materials sector*. The report is part of a series of sixteen future-oriented sector studies on innovation, skills and jobs under the same heading, commissioned by the European Commission (DG Employment, Social Affairs and Equal Opportunities). The study was executed by a consortium led by TNO (Netherlands Organization for Applied Scientific Research) and consisting of TNO, SEOR – a consultancy of Erasmus University (Rotterdam, the Netherlands) and ZSI (Centre for Social Innovation, Vienna, Austria). The study was carried out during the period January 2008-April 2009.

While the main focus of the study is on the future of skills and jobs by 2020, the study is both backward- and forward-looking in nature. It analyses recent relevant sector developments and trends and, at the same time, depicts the current state of play in the sector with an emphasis on innovation, skills and jobs. Current trends and developments form the stepping stone and fundament for the second and third future-oriented part of the study which is scenario-based, forward-looking and exploratory in nature.

Background and context

The study should be placed against the background of the EU's renewed Lisbon strategy in which securing and improving EU competitiveness and redeploying the European economy to new activities with more value-added and new and better jobs are key. In the process of change and restructuring to adapt to new realities, there is a need for a more strategic management of human resources, encouraging a more dynamic and future-oriented interaction between labour supply and demand. Without there is the risk that bigger shortages, gaps and mismatches of skills will result not only in structural unemployment but also hamper longer-term competitiveness.

Skills and jobs are of vital importance for the future of the European economy and have recently gained increasing attention, both at national and EU level. As stressed by the European Council in March 2008, investing in people and modernising labour markets is one of the four priority areas of the Lisbon Strategy for Growth and Jobs. The New Skills for New Jobs initiative launched in December 2008 (European Commission, 2008) elaborates on how this could best be done. The initiative aims to enhance human capital and promote employability by upgrading skills, as well as to ensure a better match between the supply of skills and labour market demand. More transparent information on labour market trends and skills requirements, but also the removal of obstacles to the free movement of workers in the EU, including administrative barriers would help achieve this goal, and improve occupational, sector and geographical mobility. The initiative also stresses the need to improve the Union's capacity for skills assessment (by improved monitoring and forecasting), anticipation (by better orientating skills development) and matching with existing vacancies. The current financial and economic crisis makes these challenges even more pressing. Further strengthening the economic resilience and flexibility of the European economy and its Member States calls, along with other measures, for support of employment and further facilitation of labour market transitions (European Commission, 2008a:10).

Approach and methodology

The study takes a longer term future perspective, and looks ahead to 2020, but also back, and takes a highly aggregated European perspective. While it is fully acknowledged that more detailed Member State and regional analyses are important and vitally important for anticipating future skills and knowledge needs, the European perspective has been central in this analysis. Key to the study and a common point of departure was the use of a pre-defined methodological framework on innovation, skills and jobs (Rodrigues, 2007). During the course of this study this framework has been further developed, operationalised and applied to the sector. The approach combined desk research and expert knowledge available in a broad and dedicated research team with the knowledge and expertise of 'external' sector experts. The purpose of this *common uniform methodology* is to deliver results that enable comparisons across and between sectors and hence enable the preparation of possible future actions to investigate the topic of new future jobs and skills for Europe, by encouraging a more effective interaction between innovation, skills development and jobs creation. The methodology is structured along various steps, each step providing inputs and insights for next steps to come. Overall, the methodology covers the following steps:

Step 1. Identification of economic activities to be considered (i.e. sector selection)
Step 2. Main economic and employment trends and structures by sector
Step 3. Main drivers of change
Step 4. Main scenarios
Step 5. Main implications for employment – changes by job function
Step 6. Main implications for skills – emerging needs by job function
Step 7. Main strategic choices to meet future skills and knowledge needs
Step 8. Main implications for education and training
Step 9. Main recommendations
Step 10. Final Workshop.

Further and next steps

The results of this study – along with 15 other sector studies using the same approach and being released at the same time - will serve as a guide in launching further EU-led but also other actions, by industry, sectoral partners, education and training institutes and others. One important aim of the study is to promote the strategic management of human resources and to foster stronger synergies between innovation, skills and jobs in the sector in the medium and longer run, taking into account the global context and encouraging adaptations to national and regional specificities. A very important element in further enabling and facilitating these goals is sound and continuous monitoring together with a uniform and consistent way of analysing future skills and knowledge needs for the various decision-making levels involved. The approach taken in this study aims to provide a broader framework that does exactly this. Further dissemination and explanation of the methodology at the Member State, regional and local level are therefore vital in the follow-up of this EU level study, as is its actual take-up. The results of the study include implications, conclusions and recommendations to anticipate future skills and knowledge needs. It does not in any way, however, assess or evaluate current or planned policies. Conclusions and recommendations may therefore coincide but may also oppose current policies and/or policy plans at the EU, national or regional level. The implications, conclusions and recommendations logically follow from scenarios – credible plausible sector futures – meant to better structure and anticipate possible future developments.

Looking ahead in times of crisis

Even though the year 2020 may currently seem far off for most of us, the future will announce itself earlier than we think. In times of financial and economic crisis there is a logical tendency to focus on the now and tomorrow; withstanding and surviving the crisis are prime. Nevertheless, at the same time the medium and longer term ask for adequate attention. In this current age of continuing and pervasive globalisation, strong technological change and innovation affecting production and consumption around the globe, timely preparations to be able meet future skills and job needs are called for more than ever before. This is even more true in the face of an ageing European society and ditto workforce.

Most of this study had been completed by the time the financial crisis hit and when the consequences of the economic crisis in the months following became visible. Although no specific crisis scenario had been defined, the most important elements (building bricks) for understanding the crisis are part and parcel of this study. The study also contains the elements for change, which importantly build on R&D and innovation, apart from a number of other drivers. R&D and innovation includes the development of new materials and products in glass and ceramics, as well as eco-innovation and sustainable production by improvements in energy use and ditto efficiency, recycling and re-use of materials.

Because of the strong linkages of the non-metallic materials sector with the construction sector (construction materials such as (prefabricated products of) concrete, cement and plaster, but also ceramics (bricks, tiles, sanitaryware, technical ceramics) and the dependence of still other 'luxury' parts of the sector on income and wealth developments (higher value added final consumer segments in glass and ceramics), the financial and economic crisis has hit the sector relatively hard. Overall production had declined by 11% during the period November 2007 - November 2008, which is the same as wood and wood products and comparable to other 'hard' manufacturing sectors like automotive (-21%), textiles (-15%), basic matels (-16%), recycling (-17%). The sector's exports had even decreased by 16.5%, more than other hard-hit sectors like chemicals, rubber and plastics, automotive and basic metals. Only the textiles, pulp and paper and the semiconductor, electronic and IT hardware sectors had in terms of exports suffered more during that period (European Commission, 2009; Eurostat, 2009)). Recovery in the housing (real estate) markets throughout Europe appears sluggish, with markets at best stabilising but more likely contracting over the next few years. Income development is also negatively affected, with both private and business households having less to spend and being less confident than before about the future.

At the same time, the crisis offers new opportunities to re-engineer and re-direct the course the industry at large has taken and opt for change towards a more eco-friendly and sustainable path. This does not imply that the current still limited availability of credit, the observed prolongement of payment deadlines as well as the strong declines in transport costs currently do not act to the disadvantage of European industry. Yet, global competitors are also hit, with global markets and market conditions currently being in disarray, not just or only in Europe. Encompassing measures should be taken, with strong support from the EU and Member State governments to restore business confidence and the preconditions for doing business worldwide.

This study should neither be seen as an analysis of the consequences of nor as an inventory of solutions for the crisis. The scenarios on which the analysis is built though show a number of plausible paths towards the future. They are based on the conception and conviction that the

crisis – even if its consequences for individual firms may be harsh and even if the crisis may drive certain companies out of business altogether – will be a temporary phenomenon with markets to recover in a few years (2 to 4 years) from now. In the longer term perspective of 2020 and beyond a number of other structural trends and 'givens' need to be taken into account. As technological development (automation, robotisation, nanotechnologies) and the consequences of ageing - with the post-war babyboomers seeking massive retirement over the next few years – becoming more visible soon, the need to think structurally ahead and to come up with solutions is more pressing than ever before.

Contents in three parts

The report consists of three main parts. Part I analyses recent relevant sector developments and trends and depicts the current state of play in the sector, with an emphasis on innovation, skills and jobs. The findings of Part I of the report combine original data analysis using Eurostat structural business statistics and labour force survey data with results from an extensive literature review of relevant already existing studies. While giving a clear and concise overview of the most important trends and developments, the prime function of Part I is to provide the fundaments and building blocks for Part II of the study. The findings of Part I are based on the present and the recent past. The second part of the report is future-oriented and looks at sectoral developments and more specifically developments in skills and jobs in and towards 2020. The core of part II consists of plausible future scenarios and their implications for jobs, skills and knowledge. These implications have been analysed for various job functions. In a final part III, a range of main strategic options ('choices') to meet the future skills and knowledge needs is reviewed, including implications for education and training. The study concludes with a number of recommendations for the sector (individual firms, sector organizations, sectoral partners), education and training institutes and intermediary organisations, and last but not least, policy-makers at various levels, ranging from the EU to the local level. Terminology used in this report is further explained and defined in a Glossary at the end of this report.

Part I

Trends, Developments and State-of-Play

Part I. Trends, Developments and State-of-Play

Guide to the reader

Part I presents the results of steps 1, 2 and 3 of the common methodology applied to the non-metalic materials sector broadly defined. Step 1 delineates and defines the sector. Step 2 presents the main economic and employment trends and developments in the sector (mapping) and reports the results of a SWOT (Strengths, Weaknesses, Opportunities and Threats) analysis. Step 3 analyses the main drivers of change of relevance for the sector based on a meta-driver approach and expert opinion. Part I of the report consists of 8 chapters. Chapter 2 identifies and statistically defines the sector. Chapter 3 provides an overview of the structural characteristics of the sector, including developments and trends in employment, production and value added. It contains information on work organisation (part-time/full-time, gender, age), and industrial relations, but also on emergent trends by function. It also addresses existing partnerships for innovation, skills and jobs, one of the possible policy instruments to better prepare for and adapt to the future, facilitate mutual learning and boost innovative capacity both at the sector and firm level. While not part of the methodology as such, partnerships form an interesting example of how the development of skills and jobs can be linked to innovation. Chapter 4 discusses the value chain (network) and its evolution over time, including issues of restructuring and relocation. Chapter 5 focuses on innovation, R&D and technological change, while chapter 6 analyses the impact of globalisation and trade on and for the sector. Chapter 7 highlights the importance of regulation especially in relation to employment. Chapter 8 provides the results of a SWOT analysis of the sector. Chapter 9 concludes with an overview of the most important drivers for the sector.

2 Defining the sector

Non-metallic materials sector covers a broad range of industries which are all involved in the processing of natural resources (e.g. silica sand, clay, natural stone and rock) into marketable products. This aggregated sector covers glass products, porcelain and ceramic products (tableware, tiles and flags, but also sanitary fixtures, insulators and technical ceramics), cement, concrete, lime, plaster as well as articles thereof and ornamental and building stone. It is evident that the sector traditionally has been regarded as a prime example of a resource-driven industry. (Supplier) relations with the mining industry are obviously indispensable. At the same time, it is important to keep in mind that the non-metallic materials sector consist first and foremost of well-established *manufacturing* industries.

Statistically the sector is referred to as the 'manufacture of non-metallic materials', Code 26 under NACE Rev. 1.1, and includes the Manufacture of glass and glass products (26.1), the Manufacture of non-refractory ceramic goods other than for construction purposes; manufacture of refractory ceramic products (26.2), the Manufacture of ceramic tiles and flags (26.3), the Manufacture of bricks, tiles and construction products (26.4), the Manufacture of cement, lime and plaster (26.5), the Manufacture of articles of concrete, plaster, cement (26.6), the Cutting, shaping and finishing of ornamental and building stone (26.7), and the Manufacture of other non-metallic materials (26.8). There are no significant differences in sector definitions between NACE Rev 1.1 (code 26) and the new Rev 2 (code 23) classification which will be gradually implemented as from January 2008 onwards. Data availability, however, is at a more disaggregated level still problematic, however, with few data on value added and production even at NACE 3-digit level (glass; ceramics; cement, lime and plaster; etc.).

The non-metallic materials sector consists on the one hand of firms in the construction materials industry, a part of the sector that is very dependent on business (expenditures) in real estate and infrastructure. Another part of the sector directly produces for consumers and a variety of downstream users, for instance glass and ceramics for household use (Delftware and Italian Murano glass). In terms of markets, three main product groups can be distinguished each having their own distinct sectoral characteristics: (1) building materials such as cement, lime, concrete and plaster and products thereof, and the processing (i.e. shaping and finishing) of ornamental and building stone, in the remainder referred to as construction materials, (2) applications of glass and ceramics in industry and construction (as intermediary advanced goods), and (3) ornamental and/or household glass and ceramics (as consumer goods). In this report a distinction has been made between the manufacturing of glass and ceramics (NACE 26.1, 26.2, 26.3 and 26.4) and the construction (or building) materials sector (NACE 26.5, 26.6, 26.7, and 26.8). This distinction largely follows the division by other studies and statistical descriptions of the sector (e.g. Eurostat, 2008a; 2006; Ecorys 2008, 2008a). It should be remarked though that the distinction is somewhat arbitrary, especially since part of the glass and ceramics could also be typified as part of the construction materials sector broadly defined (including, for example, sanitaryware, bricks and tiles, and glass fibres used in construction). However, as the presentation of data by Eurostat precludes a further disaggregation (e.g. for value added), the current distinction has been followed.

Significant differences exist between the various sub-sectors, not only in product characteristics and client groups, but also in terms of industry networks and value chains. Some of these differences are highlighted below; a more detailed description and background on developments can be found in next various chapters. At the same time, it should be emphasized that this analysis has been made at a high-aggregate level. This might sometimes obscure some of the developments at the (sub-)sub-sector. Yet the aggregate level allows not only to analyse developments for the EU as a whole, but also to observe trends and developments that are common to all of the sub-sectors identified. This relates to 'external' developments (e.g. globalisation, international competition, 'greening' and sustainability, ageing, etc), but also to skills and knowledge needs.

Glass. The glass sector consists of five sub-sectors: container glass, flat glass, continuous filament fibre, domestic glass, and special glass (CPIV, 2007) with in total around 17,800 companies across the EU (Eurostat, 2008a). ***Container glass*** is the largest sector of the EU glass industry, representing more than 60% of total glass production. Its products are glass containers (bottles and jars) which are widely used for the packaging of drinks, food, perfumes and cosmetics, pharmaceuticals, and some technical products such as laboratory chemicals. The EU is the largest producing region for glass containers worldwide. ***Flat glass*** is the second largest sector of the EU glass industry, representing around 22% of the total glass production. The sector covers the production of float glass and rolled glass. Flat glass manufacture is a world-wide business that is dominated by five major groups, which are: Asahi (Japan), Pilkington (UK), Saint-Gobain (France), PPG Industries (USA) and Guardian Industries (USA). Flat glass makes up 95% of the output and is used principally in the building and automotive industries. The building industry accounts for about 80% of output and the majority of the remaining 20% is processed into glazings for the automotive industry. These are laminated windscreens, side and rear glazings, and sunroofs. The main processed product for the building industry is insulated glazing in the form of double or triple glazed units, often with one layer of coated glass. The majority of rolled glass is patterned or wired glass and accounts for around 5% of the total sector output. Patterned glass is used for horticultural greenhouses, for decorative purposes and in applications where light is dispersed, for example glass partitions and bathroom windows.

The production of ***continuous filament glass fibre*** (reinforced glass fibre) is one of the smallest sectors of the glass industry in terms of tonnage, but the products have a relatively high value to mass ratio. There are 17 installations in the EU-25 countries and 7 producers: Ahlstrom, Johns Manville, Lanxess, Owens Corning, P-D Glasseiden Oschatz GmbH, PPG Fiber Glass Industries and Saint-Gobain Vetrotex., Continuous filament glass fibre is produced and supplied in a variety of forms : roving, mat, chopped strand, textile yarn, tissue, and milled fibre. The main end use (approximately 75%) is the reinforcement of composite materials, mainly thermosetting resins but also thermoplastics. Composites are used in a wide variety of industrial applications within the EU and new applications are being developed continuously. The main markets for composite materials are the building industry, the automotive and transport sectors (50%), and the electrical and electronics industry.

The ***domestic glass sector*** is also one of the smaller sectors of the glass industry with approximately 4% of total output. However, according to Diogo (2001) it accounts for 22% of the EU-15 non-ferrous metallic economical value and 40% of world market. This sector covers the production of glass tableware, cookware and decorative items, which include drinking glasses, cups, bowls, plates, cookware, vases and ornaments. The manufacture of domestic glass is very widely distributed across the EU with about 140 installations, mainly

SMEs, which often specialise in higher value added products such as lead crystal. Nonetheless production of hand-made glass products is concentrated in less than a dozen European regions, namely Marinha Grande (Portugal), the south of France, south-east Bohemia (Germany), Murano (Italy), Kosta-boda (Sweden-Finland), north-west Bohemia and south Moravia (Czech Republic), and the south of Poland. Market channels are controlled by international traders, chain retailers and independent exporters. Finally, the ***special glass sector*** produces around 6% of the glass industry output, and in terms of tonnage is the fourth largest sector. Special glass products have a relatively high value and represent an extremely broad sector covering a wide range of products. The main products are: cathode ray tube (CRT) glass for televisions and monitors, lighting glass (tubes and bulbs), optical glass, laboratory and technical glassware, borosilicate and ceramic glasses (cookware and high temperature domestic applications), and glass for the electronics industry (LCD panels).

Ceramics. The European ceramics industry has eight ceramics sub-sectors accounting for the vast majority of ceramics production with in total around 20,000 companies across the EU (Eurostat, 2008a). The *wall and floor tiles* segment of the ceramics industry is considered highly competitive internationally, with strong production concentrations in the Sassuolo (Italy) and Castellon (Spain) areas, and sizeable activities in Portugal, Germany and France. The southern European countries are, together with Germany, the most important markets for both wall- and floor tiles. Tiles are used in building and construction; the maintenance and renovation market is of great importance. New applications are the use of tiles for facades of offices, swimming pools, public areas, etc. The close relation of the *table & ornamental ware* to the end-consumer, and the need to compete on design, have given special features to this very labour-intensive industry, with its enormous array of products. While ornamental ware is produced throughout Europe, important regional concentrations of tableware producers exist in northern Bavaria (Germany), Staffordshire (England), and Limousin (France). Special requirements of the hotel and catering trades have given rise to the 'hotelware' sector, with specially designed hard-wearing ceramics. The hotelware market tends to stabilise demand for the sector's products. *Technical ceramics* are applied in a wide variety of industries, and cover both established products like insulators, insulating fittings and new applications. They supply vital elements for the aerospace and automobile industries (engine parts; catalyst carriers), electronics (capacitators; piezo-electrics), biomedical products (bone replacement), environment protection (filters) and many others. As the excellent properties of these materials are not yet widely known, the industry is making great efforts to develop new markets. The ceramics sector also comprises the manufacture of sanitary fixtures. The manufacture of bricks, tiles and construction products in baked clay (NACE 264) is in this report included in the ceramics sector, which is in line with other studies (e.g. Ecorys, 2008). However, it could also be argued that this category belongs to the construction materials sub-sector which makes clear that the delineation between the two remains somewhat arbitrary.

Cement, concrete, lime and plaster. The cement, concrete, lime and plaster industries (NACE 26.5) provide a number of different and essential inputs for the building sector; in total they account for some 1,200 companies (Eurostat, 2008a). The *cement industry*, for example, manufactures a semi-finished product, so-called 'clinker' obtained from the calcination in a high-temperature kiln of a raw mix made up of clay, limestone, and several other additives. It also produces cement as a finished product. The cement sector has around 340 plants in Europe, and four of the five largest companies in the world are European. The *lime industry* also predominantly consists of SMEs. Lime is a product with multiple applications, e.g. in civil engineering (the addition of lime to clay containing soil improves soil properties, i.e. a better densification) and in construction materials, with builders making

use of the binding properties of lime (e.g. lime-based mortars used in masonry and in plaster mixes for building facades). Lime is also being used increasingly in modern building materials, for example as aerated concrete and lime-sand bricks with good thermal and acoustic insulating properties and are easy to work with. But lime is also used in the paper industry, in animal feed production and in various other applications. There are still more than 100 companies operating in the European Union, with Germany, Italy and France being the largest producers, together accounting for about two thirds of total volume. The manufacturing industry of *articles of cement, concrete, lime and plaster* (NACE 26.6) includes, inter alia, *ready-mixed concrete, mortars, and fibre cement*, all mixtures of aggregates, binders and possibly and/or added mixtures for construction and repair, but also concrete and plaster products, such as prefabricated building components, building blocks, tiles and flags of cement, concrete or stone, and articles for non-constructional purposes (including vases, flower pots, architectectural and garden ornaments and statues. In total the sub-sector accounts for about 25,000 companies. About 40% of this number, i.e. around 10,000 SMEs EU-wide, makes up the *precast concrete industry* which produces factory-made building materials in various sizes and forms; its production involves the mixing of cement, aggregates, water, additives and admixtures, pouring them into moulds and let them harden.

Building stone and other non-metallic materials. The shaping and finishing of ornamental and building stone (NACE 26.7) is part of the natural stone industry; it also comprises the production of stone in quarries. Overall, this industry accounts for more than 40,000 SMEs, each between 5 to 100 employees. When we restrict this to the cutting, shaping and finishing the industry amounts to 33,600 companies. It includes the processing and implementation of stones, but also restoration and high-tech applications. The manufacture of other non-metallic materials (NACE 26.8) includes a mixed (rest) category of abrasive and other products, and accounts for in total 3,500 companies (Eurostat, 2008a).

3 Structural characteristics of the sector: past and present

3.1 Production, value-added and employment trends in the EU

Trends in value added

Value added of the sector as a whole (see Table 3.1) grew slower than the overall EU economy, with 1.6% against 2.3% for the overall EU economy during the period 1995-2006. In the new Member States (NMS) the sector grew *faster* than the overall economy, with 4.5% against 3.2% overall.

Table 3.1 Sector value added and overall GDP, 2006 (m euro) and 1995-2006 (% per annum)

	Non-metallic materials sector				Overall economy			
	Value added 2006	**1995-2000**	**2000-2006**	**1995-2006**	**GDP 2006**	**1995-2000**	**2000-2006**	**1995-2006**
EU	87 177	2.6	0.7	1.6	11 468 970	2.8	2.0	2.3
EU 6	46 305	1.6	-0.2	0.6	6 480 204	2.2	1.3	1.7
EU 9	33 950	3.6	1.7	2.6	4 403 041	3.7	2.8	3.2
EU 15	80 255	2.3	0.6	1.4	10 883 245	2.8	1.9	2.3
NMS	6 921	6.9	2.4	4.5	585 725	2.7	3.7	3.2
Belgium	2 783	-0.7	-0.2	-0.4	316 622	2.4	1.8	2.1
France	10 003	3.4	-0.5	1.2	1 792 140	2.5	1.8	2.1
Germany	14 296	-0.3	-2.0	-1.2	2 322 200	2.1	1.0	1.5
Italy	16 648	2.5	2.1	2.3	1 480 007	1.6	0.7	1.1
Luxembourg	237	1.2	-0.2	0.5	33 852	5.9	3.9	4.8
Netherlands	2 337	4.6	-2.7	0.6	535 382	3.9	1.7	2.7
Austria	2 840	1.8	0.2	0.9	257 897	3.0	1.8	2.3
Denmark	1 210	2.4	-2.2	-0.1	220 069	2.8	1.9	2.3
Finland	1 312	6.2	4.3	5.1	167 178	4.3	2.8	3.5
Greece	2 643	9.2	6.8	7.9	214 203	3.5	3.7	3.6
Ireland	1 140	11.8	-1.2	4.5	177 281	9.2	6.0	7.4
Portugal	2 103	8.7	-0.7	3.5	155 324	3.5	1.1	2.1
Spain	13 925	5.7	5.2	5.4	981 777	4.3	3.2	3.7
Sweden	1 172	-1.9	1.0	-0.4	316 435	2.4	3.1	2.8
United Kingdom	7 606	-0.1	-2.4	-1.3	1 912 877	3.4	2.5	2.9
Czech Republic	2365	8.1	7.2	7.6	114 060	-0.3	3.9	2.0
Estonia	167	7.5	17.0	12.6	13 223	6.3	8.3	7.4
Hungary	833	7.3	2.8	4.8	89 908	3.3	3.6	3.5
Lithuania	145	16.1	11.8	13.7	23 748	4.4	7.5	6.1
Poland	2 448	5.9	-2.6	1.2	269 756	3.5	3.0	3.2
Slovenia	312	3.6	2.3	2.9	30 455	3.3	4.1	3.7
Slovakia	651	11.1	6.7	8.6	44 574	2.9	4.1	3.6

Source: Eurostat/TNO data

In absolute terms the value added generated by the sector in the NMS is still less than one tenth of the value added generated in the EU-15. In Italy (glass and stone/marble industry) and Spain, ranked number 1 and number 3 in terms of value added, the sector grew faster than the economy as a whole. In Germany, still number 2, value added shrunk by 2% annually over the period 2000-2006. Strongest growth in the EU-15 occurred in Greece with 8% annually over the period 1995-2006. Lithuania and Estonia even showed double digit growth, with figures of almost 13% and 14%, respectively, over the same period.

Table 3.2 Sector value added in sector and overall GDP and growth, by country groups

	Sector				Overall economy			
	Level	**95-00**	**00-06**	**95-06**	**Level**	**95-00**	**00-06**	**95-06**
EU	87 177	2.6	0.7	1.6	11 468 970	2.8	2.0	2.3
EU 15	80 255	2.3	0.6	1.4	10 883 245	2.8	1.9	2.3
NMS	6 921	6.9	2.4	4.5	585 725	2.7	3.7	3.2
Winning	39 336	4.7	3.6	4.1	3 093 076	2.6	2.0	2.2
Losing momentum	8 383	2.2	-0.7	0.6	874 731	2.9	2.2	2.5
Upcoming	1 456	6.7	4.9	5.7	190 926	4.3	3.3	3.7
Retreating	37 764	1.2	-1.6	-0.4	7 276 384	2.8	1.9	2.3

Definition	Value added	Annual average growth[1]			GDP	Annual average growth		
	Million euro 2006	% 1995-2000	% 2000-2006	% 1995-2006		Million euro 2006	% 1995-2000	% 2000-2006

	Concentration >100	Concentration <100
growth	***Winning:*** Italy, Greece, Portugal, Spain, Czech Republic, Estonia, Hungary, Slovakia	***Upcoming:*** Finland, Latvia
decline	***Losing momentum :*** Belgium, Austria, Poland, Slovenia	***Retreating:*** France, Germany, Netherlands, Denmark, Ireland, Sweden, United Kingdom

Source: Eurostat/TNO data. For an explanation of the concentration index, see Box 1.

We observe winning countries (Table 3.2), i.e. where the sector has extended its already strong position and comparative advantage, in Italy, Greece, Portugal, Spain, Czech Republic, Estonia, Hungary and Slovakia. These winners are all located in south-eastern Europe where the sector is strong and developing. Besides a strong demand from the construction sector, demand also comes in the form of final consumption, for example glass. Natural resources (mines) are found in the south and the east of Europe. Finland and Latvia are upcoming; also Finland has natural resources of mineral products. The sector is retreating in north-western Europe and losing momentum in Belgium, Austria, Poland and Slovenia. This indicates that comparative advantage shifts from the west to the east, i.e. from richer countries towards countries with a smaller GDP per capita. It is also a shift to countries with a faster growing economy. If an economy grows fast, investments in real estate and infrastructure are relatively large and construction and building materials industries prosper.

[1] Note that due to missing data the EU is an approximation of the EU-27 only. GDP and trade data was not available for Bulgaria, Romania, Cyprus, Malta and Latvia. Cyprus and Malta lacked data on employment. This applies to tables 3.2 and following. The list of winning, losing momentum, upcoming, retreating (see subsequent tables in text) indicates for which countries data was available. Throughout this report, a change in volume or absolute number between two years - e.g. the number of jobs - is measured as the *average annual growth*. Similarly, a change of a share or an index is measured as *total change* over the entire period. That is, if the share in 2000 was 10% and in 2006 15%, we report a change of share of 5%.

Similar, i.e. comparable, value added data by sub-sectors is unfortunately only available for the year 2004 (Eurostat, 2008). As can be seen from Table 3.3 the largest sub-sectors in the glass industry are hollow glass and the shaping and processing of flat glass, which are in terms of turnover almost as big, but with a factor of 2.5 more firms in flat glass processing. In ceramics other than non-refractory for construction, sanitary fixtures, ceramic household articles and non-refractory ceramic products lead in terms of value added and turnover. The cement, concrete, lime and plaster industries are in terms of turnover and value added by far the largest sub-sector in non-metallic materials. More recent but limited figures on sales and production by the glass and ceramics sub-sectors are available in Ecorys (2008; 2008a). In 2006 sales in the ceramics sector amounted to €28.1 bn, with little change in output since 2000. The biggest sub-sectors were wall and floor tiles, and bricks and roof tiles, accounting for 39% and 24% of output, respectively (Ecorys, 2008). Refractory and technical ceramics accounted for 12% and 10%, sanitary ware for 8% and tableware and ornamental ware for 6% of output, the latter showing the biggest decline since 2000 (4% points).

Table 3.3 Value added, turnover and number of enterprises non-metallic materials, 2004

NACE Code		Value added	Turnover	No of enterprises
		€ million	€ million	1 000
26.1	Glass and glass products, of which:	16 000	44 000	17.8
	- flat glass	..	6 300	1.7
	- shaping and processing of flat glass	4 320	13 400	7.9
	- hollow glass	5 400	13 700	3.1
	- glass fibres	1 440	4 050	:
	- other glass	2 800	6 550	4.8
26.2 to 26.4	Ceramic goods and clay products, of which:	15 000	38 000	20.0
	1.Ceramics other than non-refractory for construction, of which:	6 300	16 000	15.0
	- ceramic household and ornamental articles	1 900	4 030	12.4
	- ceramic sanitary fixtures	1 730	4 680	0.3
	- ceramic insulators and insulating fittings	:	:	:
	- other technical ceramic products	411	815	0.3
	- other ceramic products	303	685	1.4
	- refractory ceramic products	1 750	5 180	1.1
	2. Ceramic tiles and flags	4 500	13 000	1.8
	3. Bricks, tiles and construction products	4 202	9 602	3.0
26.5; 26.6	Cement and concrete, of which:	31 000	94 000	26.0
	- Cement, lime and plaster	9 316	22 616	1.2
	- Articles of concrete, plaster, cement	22 000	70 000	25.0
26.7; 26.8	Stone and miscellaneous non-metallic mineral products, of which:	10 600	33 000	37.2
	- cutting, shaping and finishing of ornamental and building stone	5 700	15 300	33.6
	- other non-metallic products	4 900	18 000	3.5

Source: Eurostat, 2008

According to Cerame-Unie figures, sales by the EU glass sector accounted for about €37 bn which covered 97% of EU consumption.[2] In volume terms, container glass accounted for 58% of production in 2007, followed by flat glass (27%), insulating fibres (6%), tableware (4%) and reinforcement fibres (2%) (Ecorys, 2008a). For the other construction materials sub-sectors no more recent reliable estimates exist.

Box 1. Concentration index: what it is and what it measures

The concentration index assesses the relative contribution of a specific sector to the national economy compared to a greater entity, such as the EU, thereby correcting for the size of the country. In more general terms, the concentration index is a measure of comparative advantage, with changes over time revealing changes in the production structure of a country. An increase of the concentration index for a sector signifies relatively fast growth of that particular sector in the country concerned compared to the same sector in the EU.

How does the concentration index work in practice? We'll give a few examples: if sector x represents a 5% share of the German economy and a 5% share of the EU economy, the concentration index of sector x equals a 100. If sector x represents 5% of the German economy, but 10% of the EU economy, the concentration index of sector x is 50. If the same sector x represents 10% of the German economy and 5% of the EU economy, the concentration index of sector x is 200.

The concentration index concept can be applied using different indicators (variables). In our study we measure the concentration index using employment, value added and trade, in order to make a distinction between the relative performance of countries EU-wide. We distinguish between four country groupings, each signifying a different sector performance over time. If a sector in a country has a strong position (hence showing a concentration index higher than 100) and has experienced a clear index growth over the last years, the sector is defined as *winning* in that country. If the sector has a strong position, but experienced a decline of the concentration index, we say the sector is *losing momentum*. If the sector has a weak position, but gained in the past, we say that the sector in that country is *upcoming*. If the sector has a weak position and experienced a decline of the index, we say that the sector is *retreating*.

Trends in employment

Overall employment in the EU in the non-metallic materials sector amounted to 1.62 million people, which is 0.74% overall employment and 4.72% of overall manufacturing employment in the EU.

Employment in the sector has been declining table 3.4 Combined with the observed growth in value added, this implies that the sector faced substantial productivity growth. In countries with cheaper labour, like Greece and Spain and many new Member States (Bulgaria, Czech Republic and Slovenia), employment in the sector gained ground. Also in Finland, employment increased. The overall EU decline in employment was influenced by a very sharp decline in the UK (5.8%), which growing countries were unable to compensate. Besides the UK, employment shrunk in north-western European countries like Germany, France, Netherlands, Denmark, as well as in Lithuania. As a share of the EU employment, the sector is strong in Germany, Italy, and Spain. In Spain and Italy the relative share gained, whereas it declined in Germany, in line with value added developments. The overall picture is that the sector is relatively stable. Countries that already had a comparative advantage and further extended this in recent years are Italy, Spain, Austria, Finland, Bulgaria, Czech Republic and Slovenia.

Employment in more detail

[2] Note that the Eurostat 2004 turnover figures and the sales figures provided in Ecorys are not comparable.

When we consider the sector in more detail, we can best distinguish between two main groups, notably construction materials (Table 3.5 and glass and ceramics table 3.6. Construction materials include the manufacture of cement, lime and plaster (NACE 265), ditto of articles of concrete, plaster and cement (NACE 266), the cutting, shaping and finishing of ornamental and building stone (NACE 267), and other non-metallic materials (NACE 268). Glass and ceramics includes the manufacture of glass and glass products (NACE 261), ditto of ceramic goods (NACE 262), ceramic tiles and flags (NACE 263) and bricks, tiles and construction products (NACE 264).

Table 3.4 Employment[3] non-metallic materials, 2000-2006

	Level 2006	Annual growth	Share in EU	Change in share
EU	1 623 607	-1.0	100	0
EU15	1 201 802	-1.1	74	1
NMS	421 805	-0.8	26	-1
Winning	670 892	1.9	41	7
Losing momentum	313 978	-4.0	19	-4
Upcoming	101 584	2.2	6	1
Retreating	537 154	-3.4	33	-5

Definition		Level	Average annual growth (%)	Share in EU employment sector (%)	Change in share in EU employment sector (%)
		2006	2000-2006	2006	2000-2006
	Concentration >100		Concentration <100		
Growth	***Winning:*** Italy, Spain, Austria, Finland, Bulgaria Czech Republic, Slovenia		***Upcoming:*** Ireland, Greece, Sweden, Estonia Latvia, Hungary		
Decline	***Losing momentum :*** Belgium, Luxembourg, Portugal Poland, Romania, Slovakia		***Retreating:*** Germany, France, Netherlands Denmark, United Kingdom, Lithuania		

Source: Eurostat/TNO data.

Whereas the construction materials sub-sector showed a slight growth in employment, the glass and ceramics sub-sector witnessed a considerable decrease in employment over the period 2000-2006. This decrease appears rather country-specific and is shown in both Western, and Central and Eastern Europe (see the category of retreating countries underneath in Table 3.5), yet with a number of countries also winning. The decrease in employment in the glass and ceramics sector has been driven by a combination of increased productivity requirements in the face of increasing low-cost competition (ceramics and glass), and increased automation and industry consolidation (glass) (Ecorys, 2008; 2008a). Due to the fact that the construction materials sector benefitted from the construction boom in Western Europe (housing) and Central and Eastern Europe (housing and infrastructure) jobs losses due to overall productivity increases and automation where offset by extra jobs induced by higher overall demand. During the period 2000-2006 the construction sector in a number of EU Member States was able to increase its comparative advantage, which included the southern (Spain, Portugal, Italy, Greece), eastern (Czech Republic, Slovenia, Hungary, Bulgaria) and north-eastern (Ireland, Denmark, Finland, Sweden, Baltic countries) edges of Europe.

[3] Throughout this report employment is measured in working persons and concerns both employers and employees.

More than half of employment in the construction materials sector is in the manufacture of articles of concrete, plaster and cement, another 10% in the production of cement, plaster and concrete – which also includes about 14,000 people in lime manufacturing. Of this figure, according to industry data, the precast concrete industry accounted for about 250,000 and the mortar industry for about 34,000 people (source: Federceramica). The cutting, shaping and finishing of ornamental and building stone accounted for another quarter of employment, and about 40-50% of all people employed by the natural stone industry (together with production of stone in quarries accounting for 420,000 people). Employment in the manufacture of other non-metallic materials accounted for about 12% of all jobs in construction materials.

Table 3.5 Employment sub-sector construction materials*, 2000-2006

	Level 2006	Annual growth	Share in EU	Change in share
EU	849 294	0.1	100	0
EU15	672 592	0.2	79	0
NMS	176 702	-0.3	21	0
Winning	426 480	3.1	50	8
Losing momentum	19 130	-1.1	2	0
Upcoming	45 580	4.1	5	1
Retreating	358 103	-3.2	42	-9
Definition	Level In persons	Average annual growth (%)	Share in EU employment sector (%)	Change in share in EU employment sector (%)
	2006	2000-2006	2006	2000-2006

	Concentration >100	Concentration <100
Growth	***Winning:*** Italy, Denmark, Luxembourg, Greece, Spain, Austria, Portugal, Finland, Bulgaria, Czech Republic, Estonia, Slovenia	***Upcoming:*** Ireland, Sweden, Latvia, Lithuania, Hungary
Decline	***Losing momentum :*** Belgium	***Retreating:*** Germany, France, Netherlands, United Kingdom, Poland, Romania, Slovakia

Source: Eurostat/TNO. * NACE 266 Manufacture of articles of concrete, plaster, cement, NACE 265 Manufacture of cement, lime and plaster NACE 267 Cutting, shaping and finishing of ornamental and building stone, NACE 268 Manufacture of other non-metallic materials.

The sub-sectors glass and ceramics are almost as big in terms of employment. In the glass sub-sector, the manufacture of hollow glass, and the shaping and processing of flat glass accounted for a large share of employment, with about 36% and 30% of employment; the manufacture of flat glass and glass fibres accounted for considerably less employment with about 9% and 6%, respectively, with the remainder of 19% in the mixed 'other glass' category. In ceramics, about half of employment is observed under the broad heading of 'ceramics other than non-refractory for construction'. This sub-group includes amongst others ceramic household and ornamental articles (accounting for about half of employment in this sub-group) but also sanitary fixtures, ceramic insulators and insulating fitting and technical ceramics (together accounting for a quarter of employment, as well as refractory ceramic products (ditto). Ceramic tiles and flags (29%), and bricks and tiles and construction products (21%) account for the other half of employment in ceramics.

Overall the glass and ceramics has witnessed a rather strong decrease in employment of -2.1% annually over the years 2000-2006 in the entire EU. This decrease occurred mainly in north-western Europe but also in Lithuania and Greece, with an average decrease of 3.9% a year.

But, in some countries, where the sector had a strong position, the sector has been losing momentum in terms of employment: in Spain, Portugal, Bulgaria, Hungary, Poland and Romania employment decreased with 2.1% annually. Yet there also countries that can be characterised as winners: the Czech Republic, Slovenia, Austria, Italy and Slovakia. These are followed by a Baltic/Scandinavian group of upcoming 'runner-up' countries: Finland, Estonia, Sweden and Latvia. In these countries the glass and ceramics sub-sectors were able to increase their comparative advantage.

Table 3.6 Employment sub-sectors glass, ceramics and other materials*, 2000-2006

	Level 2006	Annual growth	Share in EU	Change in share
EU	774 313	-2.1	100	0
EU15	529 211	-2.6	68	-2
NMS	245 102	-1.1	32	2
Winning	111 584	2.5	14	3
Losing momentum	369 510	-2.1	48	0
Upcoming	19 676	1.7	3	1
Retreating	273 542	-3.9	35	-4

Definition		Level In persons	Average annual growth (%)	Share in EU employment sector (%)	Change in share in EU employment sector (%)
		2006	2000-2006	2006	2000-2006
	Concentration >100		Concentration <100		
Growth	***Winning:*** Austria, Czech Republic, Slovenia Slovakia		***Upcoming:*** Sweden, Finland, Estonia Latvia		
Decline	***Losing momentum :*** Italy, Spain, Portugal, Bulgaria, Hungary Poland, Romania		***Retreating:*** Belgium, Germany, France, Luxembourg Netherlands, Denmark, Ireland, Greece, United Kingdom, Lithuania		

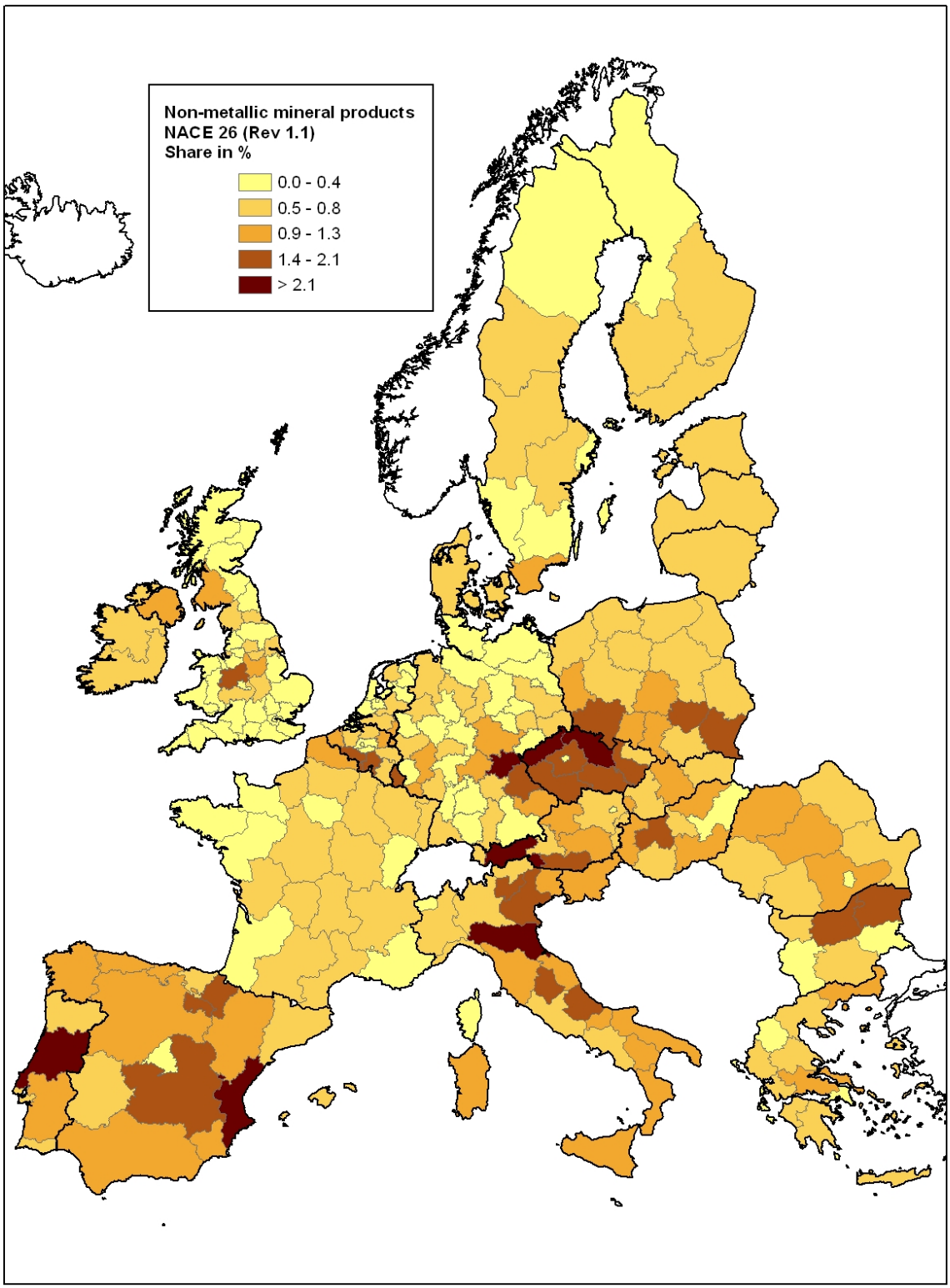
Source: Eurostat/TNO data. * NACE 261+262+263+264. NACE 261: Manufacture of glass and glass products, 262: Manufacture of non-refractory ceramic goods other than for construction purposes; manufacture of refractory ceramic products, 263: Manufacture of ceramic tiles and flags, 264: Manufacture of bricks, tiles and construction products.

Trends in regional employment

Similar to value added, Italy, Germany and Spain represent the largest share of employment in the sector (44%) with 0.71 million people. Interestingly, the countries with largest employment shares were also the largest losers in terms of employment both in the old and new Member States. This fits the general trend of employment decline in the sector (-1.0% p.a.). Notable exceptions to this trend are Greece (+3.1%), Italy (+1.6%), Czech Republic (+3.7%), Latvia (+8.5%) and Estonia (+4.1%).

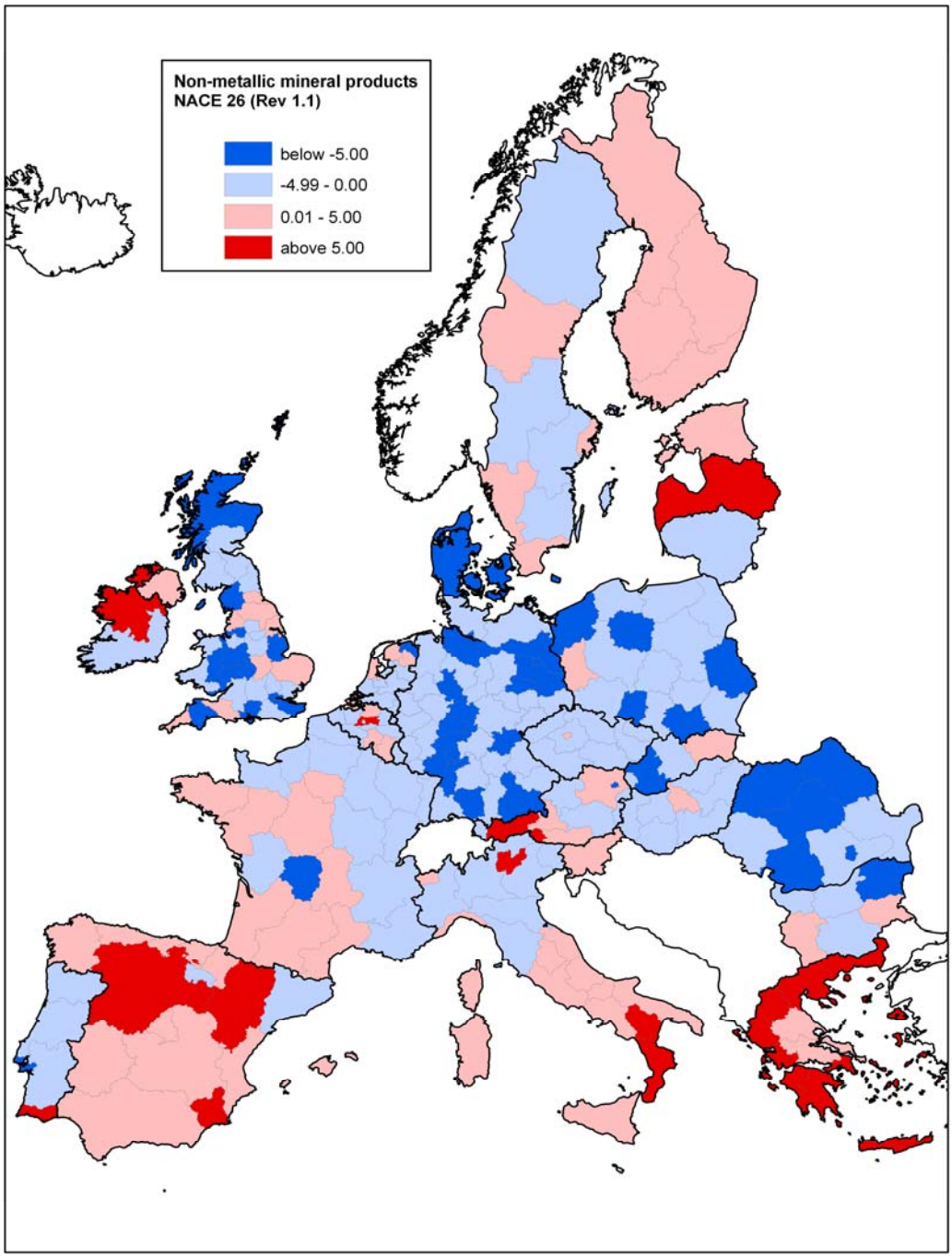
Regional specialisation (NUTS 2 level) in terms of employment is shown in Figure 3.1. The most specialised regions are located in northern Italy, south-eastern Germany (Oberfranken), the Czech Republic, southern Poland (Swietokrzyskie), Portugal (Centro) and eastern Spain. Figure 3.2 shows the annual changes in employment at regional level. Strong growth is exhibited in parts of Spain, Latvia, Ireland, Greece, and Italy. Interestingly, the highest growth areas in employment are not the traditional specialisation clusters (see Figure 3.1), which instead have experienced a decline in employment.

Figure 3.1 Vertical share: employment non-metallic materials sector in total employment by NUTS 2 region, 2006



Source: Eurostat/TNO data

Figure 3.2 Employment changes in the non-metallic materials sector by NUTS 2 region, 2000-2006 (percentage annual change)



Source: Eurostat/TNO data

3.2 Employment and value added trends - EU compared to the US, Japan and the BRICs

Most trade in the sector takes place between EU Member States, with only one third of trade relating to non-Member States. Compared to other manufacturing sectors the non-metallic materials sector is therefore only partially exposed to global competition. Comparing Europe against its traditional economic competitors, the US and Japan (table 3.7 it is clear that Europe compares favourable in terms of employment growth as well as value added growth. For the period 1995-2005 the EU-15 clearly outperformed the US and Japan with an employment growth of 3.4% compared to declines of 9.1% and 34.4% in the US and Japan, respectively. Despite the decline in employment in the US, the share of non-metallic materials in overall manufacturing employment in these countries increased, showing that other manufacturing sectors have experienced even stronger employment declines. Whether employment growth is actually a positive sign from a competitiveness perspective remains to be seen, however. A strong growth in value added of 30% compared to 21% and -35% for the US and Japan respectively, seems to indicate that it is indeed a strength rather than a weakness. However, the US has increased its value added per employee much stronger than Europe which could indicate a relative gain in competitive advantage.

The comparison with the BRICs shows a more differentiated picture. While Brazil experienced large employment growth (20%), its value added per employee declined (-6.3%) indicating a relative decline in competitiveness. India on the other hand showing the largest employment growth (22%) at the same time improved its relative competitiveness showing an increase in value added per employee by 67%. This is topped by Russia and China with their communist legacy and process of economic restructuring, standing out with massive increases in growth of value added per employee (140% and 401% respectively). Nevertheless, this growth in productivity mean that employment in China has experienced a massive decrease (-49%), while in Russia employment declined by (-11%). Value added growth has been strong in all BRICs, and especially in China (+283% in glass and glass products; +120% in pottery, china and earthenware, and +145% in other non-metallic mineral products in only 10 years time). This is proof of a rapid strengthening of the sector in the BRIC countries, not only for domestic purposes - construction being very important in the vast restructuring in most of the BRICs, but also for the export market (global competition).

3.3 Employment structure and work organisation

Firm size, industry structure and employment

Firms (‘operators’) in the sector range from large global players in cement, flat, container and fibre glass, bricks, and to a certain extent in the lime sector, to SMEs as in some sub-sectors of the ceramics industry, domestic glass, and parts of the lime industry. In ceramics SMEs are especially dominant in the wall and floor tile sub-sectors, where design uniqueness and creativeness and production flexibility are very important. SMEs also dominate the tableware and ornamentalware sub-sectors. Other sub-sectors within ceramics are more concentrated, such as the brick and roof tile sub-sector (except for Southern Europe) which is dominated by large multinational firms. High concentration is also found in refractories, vitrified clay pipes and sanitaryware, for which economies of scales and energy efficiency are important (see further Ecorys, 2008).

Table 3.7 Employment and value added trends: EU compared to the US, Japan & BRICs 1995-2005 [1]

	Employment growth (in %)	Change in share of employment of manufacturing total (in %)	Value added growth (in %)	Change in value added share (in %)	Value added growth per employee (in %)
Europe (EU 15)	3.4	0.5	30.1	0.2	25.7
Glass and glass products	-7.9	-0.2	15.5	0.5	25.5
Non-metallic mineral products n.e.c.	8.8	0.5	33.1	2.0	22.4
United States	-9.1	0.4	21.3	0.2	33.4
Glass and glass products	-19.8	0.0	-8.5	-0.1	14.1
Non-metallic mineral products n.e.c.	-5.6	0.4	32.0	0.4	39.8
Japan	-34.4	-0.5	-34.6	-0.6	-0.4
Glass and glass products	-20.2	0.0	-9.2	0.2	13.8
Non-metallic mineral products n.e.c.	-36.9	-0.5	-40.7	-0.7	-6.0
***BRICs*[2]**					
Brazil	20.0	-0.2	12.5	-0.3	-6.3
Glass and glass products	14.4	-0.1	13.5	-0.1	-0.7
Non-metallic mineral products n.e.c.	20.7	-0.2	12.2	-0.3	-7.0
Russia	-11.4	0.0	112.9	-2.2	140.3
Glass and glass products	-26.9	-0.2	85.6	-0.4	154.2
Non-metallic mineral products n.e.c.	-8.8	0.1	117.0	-1.9	138.0
India	21.8	1.0	103.0	0.8	66.7
Glass and glass products	-3.5	0.0	138.4	0.2	146.8
Non-metallic mineral products n.e.c.	25.4	1.0	99.2	0.7	58.9
China[3]	-48.5	-6.0	158.0	-4.1	400.8
Pottery,china, earthenware	-46.9	-0.8	119.7	-0.4	313.7
Glass and products	-5.6	-0.1	282.6	-0.2	305.2
Other non-metallic mineral prod.	-53.3	-5.9	145.1	-3.5	424.8

Source: TNO, based on data of UNIDO (ISIC Rev. 3)

[1] EU-15: 1995-2004 (Except France: 1996-200; Germany: 1998-2004; Greece: 1995-1998; Luxembourg: 1995-2003; Portugal: 1996-2004), Data for Europe (EU-15) is composed from data individual EU-15 countries; USA: 1997-2004; Japan: 1995-2004. [2] Brazil: 1996-2005, Russia: 2001-2005; India: 1998-2004. [3] Data for China based on ISIC Rev 2

The majority of EU glass production is highly concentrated in the flat glass and, to a lesser degree, the container sub-sectors. The continuous filament glass fibres sub-sector is made up of seven large firms. SMEs are especially active in the domestic glass sub-sector with a large number of smaller, less capital intensive installations often specialising in high value hand-made items or niche markets. Their numbers are recently falling as tightening operating conditions have forced many to close. These include increasing rules and regulations, stronger downstream bargaining power, and limits on the scope for expansion outside the EU, as well as rising input costs. Production is becoming increasingly concentrated in the hands of a few global producers, either EU-based firms, or non-EU firms with EU-based facilities. This is particularly true for flat glass, where production is concentrated in a few firms (see further Ecorys, 2008a). Still, like the ceramics sector the glass sector also accounts for a substantial number of artisanal producers of hand-made glass and ceramics. These micro-enterprises specialised in handicraft, of which there are many but mostly unknown, and not appearing in the statistics, are mainly based in France, Italy and Germany (European Commission, 2007:10), as well as in the Czech Republic and Poland and other countries.

The cement sector has around 340 plants in Europe, and four of the five largest companies in the world are European. The lime industry consists of about 100 SMEs, just like the precast concrete industry with around 10,000 production units, and the natural stone industry (which also comprises the production of stone in quarries) with for more than 40,000 micro- and small enterprises.

Table 3.8 Share of firms by firm size*. Shares (in %) and changes in share (in % points)

	Share 2006			Total share change 1999-2006		
	<50	**50-249**	**>250**	**<50**	**50-249**	**>250**
		Share of firms			*Share of firms*	
EU	95.4	3.8	0.8	0.3	-0.3	-0.1
EU15	95.3	3.9	0.8	0.5	-0.4	-0.1
NMS	95.7	3.3	1.0	0.1	0.1	-0.2
Winning	96.1	3.4	0.6	-0.4	0.3	0.0
Losing momentum	95.0	3.8	1.2	-7.3	-0.3	-0.1
Upcoming	96.7	2.6	0.7	7.3	-5.6	-1.7
Retreating	93.4	5.3	1.3	0.7	-0.5	-0.2

Source: Eurostat/TNO data. * Firm size measured in terms of number of employed and self-employed. Note that figures for the country groups winning, etc. relate to the 2005 and the period 1999-2005.

The overall majority of firms is small (over 95%) and and their share has increased somewhat over the last 7 years (Table 3.8). Small firms account for about 37% of all employment and their employment share, as well as the share of medium enterprises in employment, has also increased (Table 3.9). This gain is quite substantial in the original EU 6 and the new Member States, but only limited for the other (EU 15 minus the original EU 6) Member States. In terms of share of total employment, large firms witnessed a decline in most countries, which means that larger firms most likely have depended more on productivity, scale economies and the substitution of labour by capital. Smaller firms rely more on labour and flexibility. SMEs have a large role in the high-tech and high-end market segments. At the same time, they also play a role in the customised consumer sub-sector, notably – as an example - in the industrial districts of Italy. See also chapter 5. It should be emphasised that the currently used definition of SMEs by the EU is not seen as very appropriate by the sector as it consists of very labour-

intensive very small companies in the handicraft segment on the one hand and larger, modern and highly automated companies on the other.

Table 3.9 Employment by firm size. Shares (in %) and changes in share (in % points)

	Shares 2006			Total change of shares 1999-2006		
	<50	50-249	>249	<50	50-249	>249
	Share of employees			*Share of employees*		
EU	36.9	27.1	36.0	1.3	1.2	-2.5
EU 6	39.5	25.2	35.3	2.1	0.3	-2.4
EU 9	39.1	29.2	31.7	0.5	1.9	-2.4
EU 15	39.3	26.9	33.8	1.4	1.0	-2.5
NMS	27.3	27.9	44.8	1.8	2.1	-3.8

Source: Eurostat/TNO data. * Firm size measured in terms of number of employed and self-employed.

Part-time and full-time work

The share of part time employees is somewhat higher in the EU15 (5% in 2005) and low in the new Member States (2% in 2005). But, in both groups of countries the share of part time employment has changed with 1% over the years 1999-2005 (it was 4 and 1% respectively in 1999). However, in the countries where the sector retreats (that means the sector did have a weak position in the past and this has weakened even further over the years), the share of part time employment is higher: 7% in 2005 and that share was 5% in 1999.

The share of entrepreneurs is the EU15 and the new Member States more or less the same: 6 to 7% of total employment are self-employed. But, if the countries are divided in winning, losing momentum, upcoming and retreating countries a striking difference arises. The winning and upcoming countries do have far more (9% in 2005, against 10% and 5%, respectively, in 1999) entrepreneurs than the countries losing momentum and the retreating countries (5% and 3% respectively in 2005). Over the years 1999-2005, the share of entrepreneurs among the upcoming countries has risen strongly, by 4 percentage points. The general conclusion is that more entrepreneurial activity coincides with countries where employment gained, that is in the winning and the upcoming countries.

Table 3.10 Women's share in Employment by age and education, 2000-2006

	EU		EU 15		NMS	
	Share	**Change**	**Share**	**Change**	**Share**	**Change**
Women	28	2	25	0	39	3
Age < 40	48	-4	47	-6	53	2
Age 40 – 50	29	3	30	5	25	-6
Age > 50	23	2	23	1	22	4
Low education	29	-6	37	-3	8	-4
Mid education	55	6	45	2	81	7
High education	16	0	18	1	12	-4
Entrepreneurs	10	n.a.	8	n.a.	17	n.a.
Definition	Share in employment % 2006	Total change % 2000-2006	Share in employment % 2006	Total change % 2000-2006	Share in employment % 2006	Total change % 2000-2006

Source: Alphametrics/Eurostat/TNO data

Gender, age and education levels in sector

Women are underrepresented in the workforce in the non-metallic materials sector (Table 3.10). Only 28% of workers is female in the EU and 39% in the new Member States. This share has risen marginally in the EU-27 and the new Member States. Workers are relatively young in this sector (Table 3.8), with a little under 50% in the EU and the EU15 in the younger than 40 age category and with 53% in this category in the new Member States. This share has decreased in the EU overall and the EU15 and increased in the new Member States. The over 50 age category counts for around a quarter of the workforce in the different geographical groupings.

Workers in this sector have often a medium education level. Table 3.10 indicates that the EU, the EU15 and the new Member States have 55%, 45% and 81% in this education group. Education levels will be discussed in more detail in the following section, focusing on occupations.

3.4 Employment - main trends by job function

One of the most interesting indicators for analysing the future on jobs and skills is the trends and developments that can be identified at the (micro) level of job functions. More than aggregate employment and more than figures about gender and age distribution can changes in job functions tell us something about ongoing change and restructuring in the sector. Changes in (the need for) competences and changes in the distribution of job functions are closely linked to each other, both at the level of the sector and at the level of the firm. Competences are combined in occupation profiles, and can be distinguished in core competences, specialization competences or complementary competences (Rodrigues, 2007:34). Another distinction is between theoretical, technical and social competences (i.e. knowledge, skills and competences in ECVET) (ibid). Identifying the changes in job functions by sector is a first step towards a better understanding of the changing competence needs in the sector. Competences for the purpose of this study are assumed to be located in a general grid defined by the main occupation functions: general management, marketing, financial and administrative management, R&D, logistics, production management, production, quality and maintenance (Rodrigues, 2007:35).

As a first step towards identifying trends in competences, the observed changes in the distribution of job functions over time will be analysed, using Labour Force Survey (LFS) data.[4] In the second part (the scenario-based future-oriented part), a further elaboration of these changes on the need for new and existing competences will be provided. The analysis starts with an analysis of the state-of-play, i.e. the situation as per 2006. Subsequently, changes in job functions over time are discussed, in general (overall) and for different categories of workers classified according to educational level.

If we consider the skills in general, no big shifts can be observed at the aggregated level; the non-metallic materials sector is a stable, conservative sector in terms of skill mix. The relative share of engineers gained somewhat over the years, as well as extraction and building workers, glass mechanics plant operators, and drivers and mobile plant operators. The share of labourers declined. This shift in skill structure indicates a higher capital intensity (gradual substitition of labour for capital).

[4] Data on occupational structure follow the availability of overall employment figures presented earlier.

Generally, the lower educated lost ground overall, with steep losses in the other craft trades workers and plant operators. Those ranks are substituted by mid-educated workers. In the overall EU, the share of high educated employees remained the same; in the new Member States however, it declined, whereas its share gained in the EU15. Everywhere, higher educated managers, business professionals, and plant operators gained ground. This again is indication of a higher capital intensity of the sector.

Table 3.11 Occupation shares in sector by country grouping, 2006

	EU 15	NMS	EU	Winning	Losing momentum	Upcoming	Retreating
TOTAL	100	100	100	100	100	100	100
Managers	7	6	7	5	6	11	7
Computing professionals	1	1	1	0	1	1	1
Engineers	6	5	6	5	5	4	8
Business professionals	3	3	3	4	2	2	3
Other professionals	5	5	5	7	4	5	4
Office clerks and secretaries	9	5	8	8	6	7	10
Service workers	1	1	1	1	0	1	1
Extraction and building workers	14	12	14	16	12	15	11
Metal workers	6	9	7	6	8	7	7
Potters. glass making	9	15	10	10	16	9	8
Other craft trades workers	1	1	1	1	1	1	1
Glass. ceramics plant operators	10	10	10	10	10	7	10
Metal. mineral plant operators	4	5	4	5	5	10	2
Drivers. mobile plant operators	9	8	9	9	8	11	7
Other plant machine operators	6	5	6	6	5	4	7
Labourers	9	10	9	7	11	6	12

Note: The country grouping (Winning, Losing momentum, Upcoming and Retreating) is based on employment (Table 3.3)
Source: Eurostat/TNO data

If the changes in occupations in the four country groupings are regarded (Table 3.11 and 3.12), the strongest decrease of labourers is in those countries where the sector has a declining

comparative advantage (losing momentum). Labourers have been replaced by managers, professionals, extraction workers, metal workers and potters and glass makers. The shifts in numbers are quite large. Given the rather high absolute numbers of jobs, these strong shifts indicate restructuring processes, presumably because the sector is losing momentum. In the winning countries – countries that have extended their comparative advantage in this sector – the changes are less robust, and show a replacement of clerks and secretaries, potters and glass makers and ceramic and mineral plant operators by engineers, professionals, extraction and building workers, and drivers /mobile plant operators and other plant machine operators. This is a strong indication of a higher capital intensity of the sector in the winning countries.

Also in educational levels, the restructuring is the strongest in the countries were the sector is losing comparative advantage (i.e. losing momentum). Among the low educated ranks, the share of low educated plummeted; in 2006, the share of low educated was 12% lower than in 2000. This especially occurred among the lower ranks in the organisation: all kinds of workers and operators (the 'blue collars') were replaced by mid educated people. This change also occurred among the countries where the sector gained comparative advantage (the winners) over the years 2000-2006; but this change is less strong than among the countries were the sector is losing momentum. The replacement occurred especially between low and mid educated employees. Among the higher educated the changes are weaker. It is striking however, that higher educated gained in the countries were the sector gained comparative advantage; in the winning as well as in the upcoming countries the share of high educated employees in 2006 was 2 to 3% higher than in 2000. These gains are very specific: they occurred among professionals, managers, computing professionals and engineers. Among the upcoming countries the gains among such occupations are striking. In the countries losing momentum the share of high educated employees declined even with 3 percent; the share of high educated managers rose steeply, but among the professionals it declined. Among the countries were the sector is retreating, it remained the same and the shifts between the higher educated occupations are smaller. It looks like that the sector in those countries is not restructuring as in the countries losing momentum, and that the sector is just loosing ground.

Table 3.12 Occupation share changes in sector, 2000-2006

	EU 15	NMS	EU	Winning	Losing momentum	Upcoming	Retreating
Managers	0	1	0	0	2	2	-1
Computing professionals	0	0	0	0	1	0	0
Engineers	1	1	1	2	3	-1	2
Business professionals	0	1	0	0	1	-1	0
Other professionals	1	-5	0	2	-17	2	1
Office clerks and secretaries	0	-3	-1	-3	-1	0	0
Service workers	-1	-1	-1	-1	-2	0	-1
Extraction and building workers	2	4	3	7	6	0	-2
Metal workers	-1	1	0	-1	5	0	-1

Potters. glass making	-2	2	-1	-3	7	-4	-1
Other craft trades workers	-1	-1	-1	0	0	0	-1
Glass. ceramics plant operators	1	2	2	-2	4	-1	4
Metal. mineral plant operators	-2	0	-1	-2	0	0	-1
Drivers. mobile plant operators	1	2	2	2	4	3	1
Other plant machine operators	0	2	0	2	2	0	-1
Labourers	-1	-8	-3	-3	-14	-1	1

Source: Eurostat/TNO. data

3.5 Productivity and labour costs

The apparent labour productivity (Table 3.13) in the non-metallic materials sector was €46,000, or 12.5% above the non-financial business economy average in 2004 (Eurostat, 2008). Within the sector, the values for apparent labour productivity ranged from €37,000 (stone and miscellaneous non-metallic materials) to €58,000 per person (cement and concrete). The wage adjusted labour productivity ratio for the whole sector (160%) was also moderately higher than the average ratio for the non-financial business economy (148%) in 2004. In this respect, there were notable differences between Member States: Romania had a ratio of 59.4 percentage points higher than the non-financial business economy average, and Bulgaria's ratio was even 96.8 percentage points higher. These and several other Member States (the Czech Republic, Estonia, Cyprus, Latvia, Poland and Slovakia) reported wage adjusted labour productivity ratios between 200% and 300% (Eurostat, 2008).

Table 3.13 Labour productivity

	Apparent labour productivity (€ thousand)	Average personnel costs (€ thousand)	Wage adjusted labour productivity (%)
Non-metallic materials	46.0	28.5	160.0
- Glass and glass products	41.0	28.0	147.0
- Ceramic goods and clay products	40.0	26.0	150.0
- Cement and concrete	58.0	31.0	180.0
- Stone and miscellaneous non-metallic materials	37.0	27.0	135.0

Source: Eurostat (2007)

3.6 Industrial relations

Key actors in the non-energy extractive industries are united in the *Non Energy Extractive Industry Panel* (NEEIP) which is not an association but a panel to co-operate on issues of common interest. The participants in the Non Energy Extractive Industry Panel are: CEMBUREAU - The European Cement Association; CEPMC - Council of European Producers of Materials for Construction; CERAME-UNIE - Liaison Office of the European Ceramic Industry (i.e. the European federation representing the producers of ceramic products); EULA - European Lime Association; EUROGYPSUM - Association of European

Gypsum Industries; EUROMINES - European Association of Mining Industries; EURO-ROC - European & International Federation of Natural Stone Industries; EXCA - European Expanded Clay Association; IMA-EUROPE - Industrial Minerals Association – Europe; and UEPG - European Aggregates Association. CERAME-UNIE is the. The European glass producers are represented by the *Standing Committee of the European Glass Industries* (CPIV). The CIPV represents both the national federations as well as the sectoral associations. The latter include the EDG - European Domestic Glass Committee (Domestic Glass); FEVE - Fédération Européenne du Verre d'Emballage (Container Glass); ESGA – European Special Glass Association, GLASS FOR EUROPE - Europe's Manufacturers of Building, Automotive and Transport Glass; APFE - Association des Producteurs de Fibre de Verre Européens (Reinforcement Glass Fibres); and ICF - International Crystal Federation (Crystal Glass). The ECFIA (European Ceramic Fibres Industry Association) the ceramic fibres industry (i.e. Refractory Ceramic Fibres' (RCFs)).

Workers' interests are represented by the European Trade Union Conference (ETUC) and more specifically the European Mine, Chemicals and Energy Workers' Federation (EMCEF)(a member of ETUC). The EMCEF organises members in a wide range of industrial areas, ranging from energy, mines, chemicals, pharmaceuticals, rubber and plastics, glass and pulp and paper. EMCEF is represented in four Social Dialogue Sectoral Committees (Extractive Industry[5], Gas, Chemical, Electricity) dealing with industrial, technical and legal matters; the Social Dialogue Sectoral Committees also include employers' representatives.

The sectoral dialogue at European level provides a platform for employers and trade unions to identify issues of mutual interest, and put their views to the Commission during consultations on EU initiatives that are likely to affect their industry. The development of sectoral dialogue has accelerated since the Commission's 1998 decision to establish sectoral social dialogue committees.

One of the results of these sector dialogues is the 2006 European multi-sectoral Social Dialogue Agreement on Workers Health Protection through the Good Handling and Use of Crystalline Silica and Products containing it. The agreement aims at improving the protection of over 2 million workers employed in the EU, with as signatory sectors aggregates, ceramics, foundry, mortar, pre-cast concrete, cement, mining, glass (special glass, flat glass and packaging glass), insulation materials, natural stone, and industrial minerals. The principal tool for implementation of the agreement is a *Good Practice Guide on Dust Prevention in the Workplace: Respirable Crystalline Silica* including task sheets compiled by the sectors (Respirable Crystalline Silica Essentials, and Task Guidance Sheets describing good practice techniques for various common tasks.

3.7 Partnerships for innovation, skills and jobs

One of the central tenets of the renewed Lisbon Strategy is the partnership concept; by building a European partnership for growth and employment, the reforms needed to boost growth and employment will be facilitated and speeded up (European Commission, 2005). Partnership in this view "mobilises support" (mobilisation) and "gets the different players at work together" (collective effort), as well as "makes sure that the(se) objectives and reforms are taken on board by all the various players" thus spreading ownership (ibid, page 14). In the implementation of the European Cohesion Policy, the partnership principle is fundamental as

[5] Social Dialogue Committee „Extractive Industries" (SSDCEI).

well. The EU recognises the importance of involving local and regional actors, in particular in areas where greater proximity is essential such as innovation, the knowledge economy and new information and communication technologies, employment, human capital, entrepreneurship, support for SMEs and access to capital financing. Beyond that public-private partnerships and further improvement of governance in the fields of entrepreneurial innovation, cluster management, innovation financing are promoted at all levels – from the local to the regional, the national and the EU level as well as across sectors. Partnerships for innovation, skills and jobs, in connection with technology platforms, industrial high level groups, as well as lead market and cluster initiatives are being promoted at both European and national level.

Existing partnerships for innovation, skills and jobs generally show a number of characteristics, which include:

- *Involvement of all relevant actors,* ranging from companies, research organisations, education and training institutes to public administration and others.
- *Cross-sectoral approach:* even though partnerships may be assigned to a specific sector, they often work across different business sectors.
- *Cross-thematic approach, i.e.* linking innovation, skills and jobs.
- *Inclusion of general human needs into the partnership strategy:* human needs, such as housing, health or mobility can be part of the formulated partnership vision or strategy
- *Long term commitment of actors (members).*
- *Joint problem solving,* i.e. working on problems that cannot be met by one member alone
- *European dimension,* i.e. being established at the European level.

Partnerships for innovation, skills and jobs can create a leverage effect for innovation, especially if broader *general human needs* are taken into consideration.[6] For instance, partnerships in the tourism sector aiming at developing 'leisure' should combine knowledge in tourism with, e.g., culture, sports and environment. A partnership aiming at developing the quality of habitat consequently should combine knowledge on at least construction, furniture, electronics and urban management. Partnerships for innovation, skills and jobs integrating general human needs on European level are still very rare.[7] It is likely to find more inclusive partnerships on the national and regional level.

Whereas the potential benefits of partnerships are clear, finding strong examples that fit the above characteristics at EU level are still difficult to find. There are, however, good examples in various sectors at the national and the regional level. Some of these stand out in terms of partnership approach, innovation capacity, approach for skills development, or their job maintaining and job creating capacity. Examples include the City Fringe Partnership for developing regional job opportunities in the printing sector and the ERRAC and EURNEX network in the rail sector where a European approach is combined with a strong effort to integrate latest research results in an virtual European training curriculum.

Partnerships, networks and clusters on innovation, jobs and skills often face similar barriers and obstacles, whatever sector is at stake. These include:

[6] An argument put forward by professor Rodrigues at the workshop "Innovation policies for a knowledge intensive economy – assessing the European experience" in 2005 in Brussels.

[7] Outside the scope of the current series of studies, there is at least there is one good example, the European Construction technology platform (see http://www.ectp.org/default.asp).

- *Restricted scope:* Partnerships often are set up in order to solve problems which can not be met by one partner on its own. The problems, thereby, are either defined bottom-up or articulated by the politics in a top-down process. In the latter case, the scope of partnership is limited to their given geographical scope and/or their thematic focus (If partnerships are established top-down as instrument to address specific problems they are usually restricted to the policy represented by the awarding authority, e.g. a particular Ministry). Similarly, partnerships and networks established at the European level, such as e.g. networks of excellence, technology platforms, etc. have a specific thematic focus (in this case innovation in research and development).
- *Short-term nature:* Partnerships which are built up by means of public funding are often project driven, feature a short term nature and, generally, are not sustainable due to their dependence of a single fund.
- *Weak direct links between skills, jobs and innovation processes:* Skills upgrading and job opportunities are a result of innovation processes. Therefore, partnerships which focus on innovation do seldom focus on skills and jobs with the same strong interest.
- *Sectoral restrictions:* In general partnerships working on international or European level seem to be more likely to occur in strongly internationalised economic sectors with a common universal challenge (e.g. pollution or sustainable development). Then they are mostly limited to the problems they want to address.

Initiative for Sustainable Cement Industry

The World Business Council for Sustainable Development (WBCSD) brings together some 190 international companies in a shared commitment to boost sustainable development through economic growth, ecological balance and social progress. More than 30 countries and 20 industrial sectors are part of the WBCSD.

The energy intense Cement production has many links to issues concerning sustainability such as e.g. climate change, pollution, resource depletion, worker's health and safety. In order to address these issues and to provide a vision as well as a strategy for a more sustainable approach for the industry's future growth, the WBCSD collaborated with enterprises of the industry sector and implemented a sector project on cement.

As a result, the Initiative for Sustainability in the German cements industry (www.initiative–nachhaltigkeit.de) was founded. A long term vision for the cement industry was developed, thereby linking all three dimension of sustainability, the ecological, the economic and the social sustainability. The Initiative is lead by representatives of the social partner organisation and, thus, is more exclusive than other partnerships. However, several experts are integrated on the project level. The initiative focuses on process innovations of the following four topics:

- Biodiversity
- Saving resources
- Mobility
- Qualifications.

The initiative seeks to include latest developments of sustainable production and processes in the advanced vocational training of the employees. The knowledge gained is disseminated via workshops. The initiatives pursues two objectives: (1) to disseminate project results and knowledge in the enterprises; and (2) to foster Lifelong Learning in the cement industry.

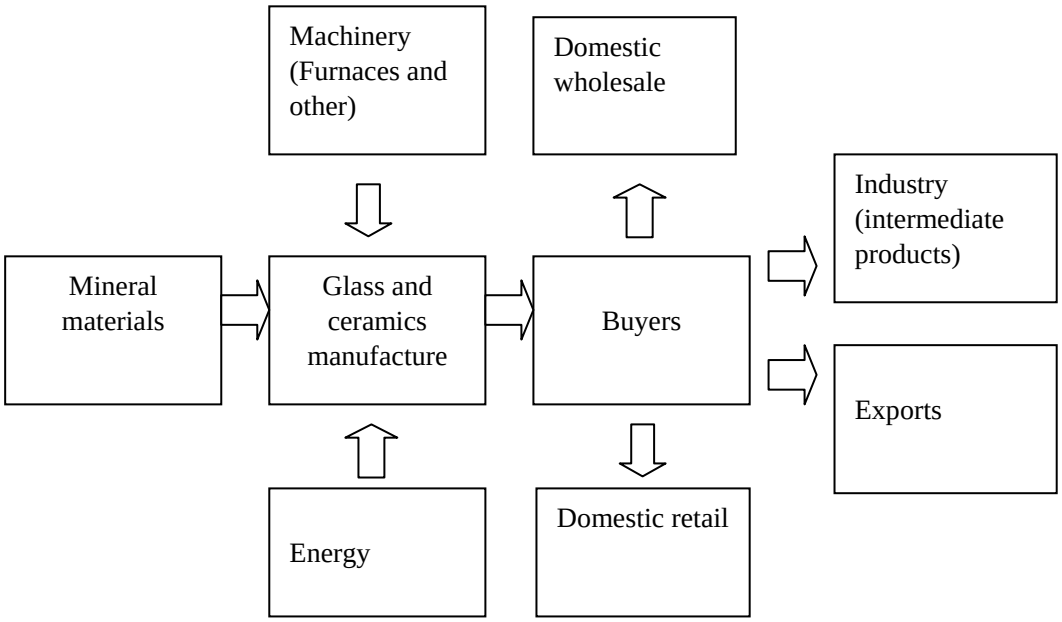
European Technology Platform (ETP) on Sustainable Mineral Resources

Another important initiative with impact for the glass, ceramics and construction materials sector is the establishment in 2005 of the *European Technology Platform (ETP) on Sustainable Mineral Resources* within the context of the Seventh Framework Programme (FP7). Sectors include oil, gas, coal, metal ores, industrial minerals, ornamental stones, aggregates, smelters as well as technology suppliers and engineering companies. Among the key objectives are: 1) securing the future supply of /access to European raw materials, 2) supporting the revival of exploration of Europe's mineral potential, 3) developing innovative and sustainable production technologies, 4) implementing best practices, 5) reuse, recovery and recycling as well as new product applications, and 6) creating European added value through RTD-based technology leadership, education and training.

4 Value chain, networks and actors

The value chain in the glass and ceramics sub-sector is presented below in figure 4.1

Figure 4.1 The value chain in the glass and ceramics sub-sector



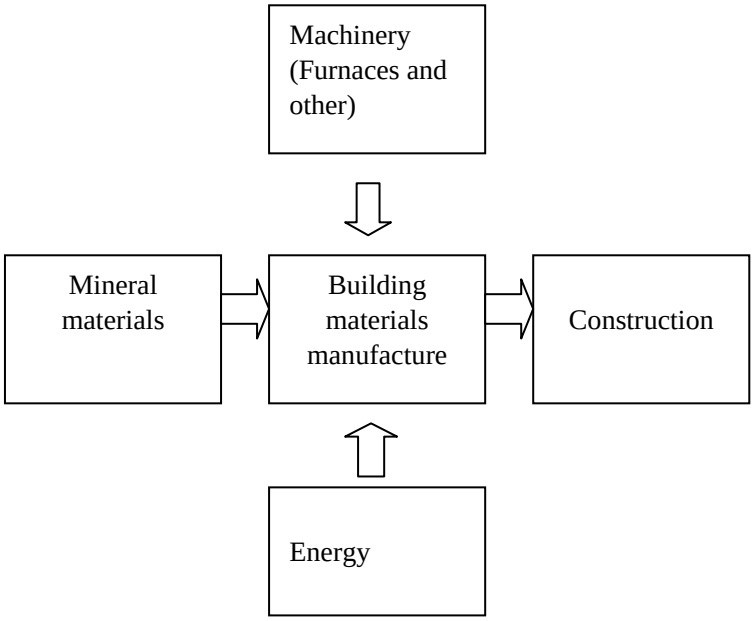
Source: TNO data

The following important features of the value chains should be noted:

- Since these are mostly intermediate products, long-term relations with industrial producers are paramount.
- Many firms in the sector operate in global supply chains.
- There exist production clusters in certain sub-sectors with common labour and technology pools.
- Consumer sub-sector works with retailers/retail chains, large traders and independent exporters.

The value chain for the glass and ceramics sub-sector is presented in Figure 4.1. This is a relatively complicated and involves raw materials, manufacture, wholesale and retail buyers of end-products, as well as industries buying inputs from the sector. The value chain for the building materials sub-sector is presented in Figure 4.2

Figure 4.2 The value chain in building materials



Source: TNO data

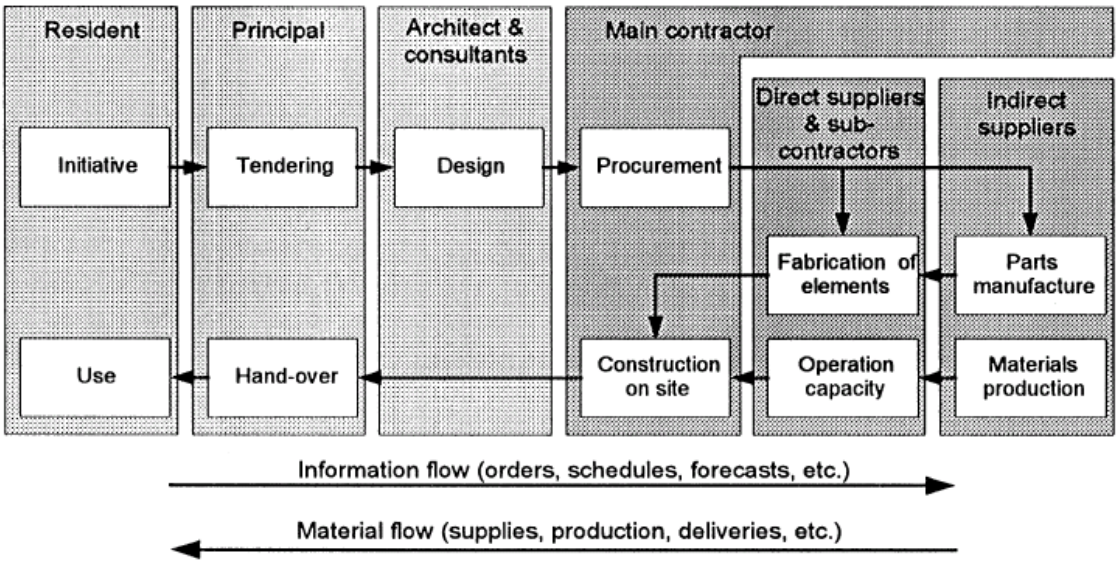
Various studies have pointed out the important role which the building materials sector plays in the construction supply chain (European Commission, 2007a; Pries and Janszen, 1995). The construction supply chain is characterised by the following features (Vrijhoef and Koskela, 2000):

- All materials are directed to the construction site where the building object is assembled. In contrast to manufacturing systems, the construction assembly is set up around a single product.
- It is a temporary supply chain producing one-off construction projects through repeated reconfiguration of project configurations. This results in a network that is typified by instability, fragmentation, and especially by the separation between the design and the construction of the built object.
- It is a typical make-to-order supply chain where every project creates a new, more or less unique product or prototype. Nonetheless the process can be very similar across various projects.

Figure 4.3 illustrates the position of the building materials industry. It shows that the sector provides a fundamental role as the supplier of the basic material for construction. As such, materials production can be found at an early stage of the materials flow in a supply chain. Material production basically adds value to extracted minerals provided by the mining industry. In terms of construction minerals, Europe is self-sufficient despite large quantities used (3 billion tonnes annually) due to many suitable resources. Transport costs dominate the price of these minerals giving rise to predominantly local or regional markets and limited international trade (European Commission, 2007a). While being an earlier player in the materials flows, materials production is involved at a much later stage in the information flow of the supply chain which could give rise to problems in the area of governance and coordination. Because suppliers of materials (as well as machinery) often are the main sources of innovation in construction (Miozzo and Dewick, 2002), the innovative potentials in construction are often sub optimally exploited due to information asymmetries (ECCREDI,

2002). Various options have been mentioned to improve this communication deficiency in the construction network by replacing the usual temporary chains with permanent, stable chains but their wider application has been slow. An example is the sequential procedure in Vrijhoef and Koskela (2000). Here the idea is to structure the site work as successive realisations of autonomous sequences.

Figure 4.3 Sequential procedure in the construction industry



Source: Vrijhoef and Koskela (2000)

5 Sector dynamics and the role of technological change, R&D and innovation

Technological change, R&D and innovation in the non-metallic materials sector should be analysed at sub-sector level because of substantive differences and specificities between its sub-sectors. Instead of the distinction between intermediary bulk goods, consumer goods and intermediary advanced goods made in chapter 2, for this chapter we follow the well-known Pavitt taxonomy for different sectoral patterns of innovation, differentiating between traditional manufacturing, resource-based industries and specialised suppliers (Pavitt, 1984: Giuliani et al., 2005). This chapter concludes with a number of important R&D and innovation topics of current and future interest.

Patterns of innovation – a classification of the non-metallic materials industry

Glass and tile manufacturing as well as porcelain and ceramic products can be typically classified as ***traditional manufacturing***. According to the literature (Pavitt, 1984: Giuliani et al., 2005), innovation and technical change in traditional manufacturing is predominantly supplier-dominated because major process innovations often are introduced by producers of inputs (e.g. machinery or materials). Opportunities for technological accumulation and learning are focused on incremental improvements and modifications in production methods and on product design. Furthermore, there is little scope to appropriate innovation (as it

mainly involved adoption or imitation) and barriers to entry for innovators are low. This typology fits fairly well to this part of the sector. The ceramic tile industry probably provides the most illustrative and well-documented case examples. Traditionally tiles were manufactured by craft-based manual processes often following different methods. Starting in the 1970s, the process has been gradually automated and procedures have been standardised considerably (Albors, 2002). Ceramic production equipment (such as microprocessor-controlled sensors in kilns) is given as an example of flexible and efficient advanced technologies adopted by small firms to produce specialised goods in short runs, and innovations emerged from collaborative efforts with local machinery suppliers (for example, to adapt equipment for shorter runs or special tasks to compete in rapidly changing niche markets) (Rowley, 1997). Other examples are the manufacture of large formats, development of special glazed surfaces and rectified borders, automation of the paste production process, development of new quality control procedures, of physical and chemical quality standards, new adhesives for tile laying. Therefore the ceramics industry is typically located and organised in industrial districts. Especially the Italian and Spanish tile districts have been well-documented.

The second sectoral classification is formed by natural resource-based industries. This typically covers the ***bulk-based manufacture of building material*** (cement, lime and plaster). Here innovation and technological change are also primarily supplier-led and show dissimilar characteristics from traditional industries. These industries rely strongly on advancements in basic and applied science. This is often carried out by public research institutes (due to low appropriability conditions) but also by large manufacturers and input suppliers (e.g. chemicals). The results of this research are appropriated through patents while economies of scale are needed to make sufficient returns on investment in research. Moreover, the building material industry is a paradigmatic case of a mature sector where the rate of innovation is relatively low. Similar to the construction industry at large, the most important technologies and techniques have been developed centuries ago. Competition mainly takes place through cost reduction and on the basis of capacity delivery. Therefore the incentives and motivation to innovate from within the sector are relatively poor. Nonetheless, the importance of international environmental health, safety and quality standards are increasingly an issue for the industry pushing efforts to improve industry performance.

Finally, glass fibre and advanced ceramics can be seen as cases of specialised suppliers. These are very ***technology-intensive manufacturing sub-sectors*** dominated by relatively young and small firms supplying high-end market segments. There are low barriers to entry due to immaturity of the sector and the presence of new market niches. These high-tech sub-sectors invest in R&D and innovation, but lack of resources both financially and in terms of high-educated personnel (engineers) form a constraint. Due to the advanced state of the technology, contacts with scientific research are crucial to remain at the innovative and competitive edge of the industry. *Advanced ceramics* companies therefore rely on central research laboratories. However, few laboratories are large enough to do everything themselves which explains the general tendency to contract out testing to the public sector (Senker, 1993). An additional advantage is the personal access (know-who) to relevant scientists (as sources of recruitment). However, ceramics processors need to combine such scientific knowledge with more tacit, in-house knowledge of the process plant. The *glass fibre* sub-sector can be regarded as part of the opto-electronics industry with applications in many high technology products and markets. Its breakthrough came in combination with intense laser beams. This convergence allowed for a highly effective means of transmitting information. The opto-electronics industry is now characterized by large numbers of high-tech SMEs concentrated in regional

clusters and engaged in symbiotic relationships with multinational firms (Hendry et al., 2000). Many final markets are made by national champions (defence, telecoms) or are international consumer markets (IT, consumer electronics). Many opto-electronics firms originated as spin-offs from large firm 'incubators'. Large firms withdraw from non-core activities and create space for SMEs (as, for instance with Pilkington).

It should be noted that there is a large difference between the advanced glass sector and the customised consumer glass sub-sector – with further automation of processes in highly concentrated manufacturing in advanced glass manufacturing against craftmanship in the latter tableware sector with obviously a need for skilled craftsmen.

R&D and innovation topics

There are a number of R&D and innovation issues that offer opportunities and require specific attention for the oncoming years, notably: 1) recycling and the re-use of materials, 2) R&D and SMEs, and 3) counterfeiting and IPR protection, 4) knowledge clusters, and 5) energy-intensity / increasing energy-efficiency.

Special topic 1: recycling and (re-)use of materials/components. Innovative approaches of recycling and re-use of components as well as increased resource efficiency are important topics that need further exploration and action. The demand for energy and raw materials has drastically increased during the last decade, which has led to cost increases. At the same time, sustainability, climate change and energy savings have become important trends. Together they make that recycling and re-use have a high potential for growth, especially in the construction sector. There is also a clear need for the transfer of knowledge to and an increase of awareness of the construction industry of the key sustainable development issues in relation to (the procurement of) construction materials. Current practices in recycling and re-use differ substantially between Member States, with the overall picture being diverse and mixed across Europe. Note that recycling as an issue has also been addressed in the *Raw Materials Initiative* of the European Commission in November 2008 (see also Annex III).

Special topic 2: R&D by SMEs. Lack of resources form a barrier to R&D, especially to small and micro-enterprises which are amply represented in the sector. Public co-financing of R&D is one the ways to address this issue, as is the support and setting up of test plants (similar to CO2 test plants) in order to actually test new materials and hence facilitate the commercialisation of innovation.

More in general, attention should also be paid to R&D and the application of new technologies in untraditional sectors; this could lead to promising business niches, for instance, in the ceramics sector. Such applications will require efforts by ceramics technology experts but also in investing in collaborative research with end-user companies or partners in other sectors to discover new applications for ceramics technology (see Ecorys, 2008).

Special topic 3: counterfeiting and IPR protection. Especially in the glass and ceramics sub-sector counterfeiting is regarded as a problem. Measures such as origin marking for ceramics for third country producers of tableware and ceramic tiles are a step towards further protection of intellectual property (IP). IP rights should be further protected, and adequate protection is the more important since new innovative products are seen as one of the ways to strengthen EU competitiveness.

Origin marking is, however, not easy. Major issues and concerns attached to marking schemes include the technical difficulty of marking products; the administrative burden and overhead costs related to imported goods that are finished in the EU; the uncertainty about the marking requirements; and markings that are unclear about whether the product has or has not been produced in the EU (Ecorys, 2008).

Special topic 4: knowledge clusters. In the ceramics sub-sector knowledge clusters of SMEs have emerged that fuel product and process innovations and increase competitiveness. Examples are observed in Spain and Italy where the close geographical proximity of ceramic wall and floor tile producers means that the transfer of product or process improvements goes quickly. The same holds for tableware producers in Bavaria (Germany), Staffordshire (UK) and Limousin (France); also in the brick and roof tiles sub-sectors clusters are forming (Ecorys, 2008). Further strengthening of these clusters and best practice examples could be used for dissemination and transfer of knowledge to other sub-sectors.

Special topic 5: increasing energy efficiency/energy-saving technologies. Some sub-sectors are characterised by a high energy intensity; this especially holds for the ceramics sector. For instance, the production of bricks is highly energy-intensive, with energy costs accounting for up to 30% of total production cost. Brick production is responsible for approximately half of the total energy used by the whole ceramics sector (Ecorys, 2008a). The main energy source is gas, constituting more than 80% of the total source of energy, and responsible for a serious share of CO2 emissions. Regulations imposing the reduction of CO2 emissions are very costly and they are related to several (nearly all) stages in the ceramics production process. Improving energy use and increasing the energy efficiency is important as energy is expected to become scarcer and therefore more expensive in the future, and a reduction in energy use can help to address CO2 and sustainability goals. Eco-innovation requires research on reduction of energy consumption (and waste prevention) with know-how becoming more important and requiring an increasingly high-skilled labour force. This implies a change in EU ceramic production process in the longer term, aiming at a decreased dependency on traditional energy sources and a strengthened position on niche markets with ‘quality’ products (e.g. the eco-label). Current energy-saving regulations – most importantly - IPPC and ETS) already lead companies to invest more in innovation and R&D. The ETS Directive, for example, forces EU manufacturers to be more energy efficient and to be less dependent on expensive energy-sources (substitution of heavy fuel oil and solid fuels with clean fuel). See further chapter 7 and Ecorys (2008).

6 Trade, globalization and international competition

6.1 Trade

The non-metallic construction materials industry is a clear example of an industry that produces tradables. Due to the bulky character of its products, in combination with unit costs of transport and relatively low unit selling prices, *building materials* are usually regarded as

not fully tradable, but only as regionally or locally tradable. This holds for example for cement, lime, bricks and roof tiles. Therefore, the sector is, usually located not far from the excavation sites and near the consumer markets. Cement, for instance, is essentially a local product. Because of its weight, cement supply via land transportation is expensive, and generally limited to an area within about 200-300 km of any one plant site. Sea transport, however, is a different matter. Long distance transport via water is becoming more common. For instance, it is less expensive per ton to cross the oceans with a 35,000-ton cargo of cement than to move a truck full 300 km on land.

Other products, such as tableware, glass fibres, and ceramic tiles, of relatively low weight, are traded globally. This especially holds for the higher value end of the range (high quality and added value). For instance, the US is the most significant export market for high-quality ceramics, where over a quarter of EU output is sold. The majority of EU ceramic exports are wall and floor tiles, which originate primarily from Spain and Italy, as well as tableware, many of which are sold to the US. The same holds for refractory products accounting for nearly a fifth of EU ceramics exports, 10% of which is sold in the US (Ecorys, 2008). Tableware is the most imported ceramic product into the EU, especially the relatively low-value 'everyday' tableware that arrives in high volumes (predominantly) from China (ibidem)(see also section 6.2).

As can be seen from Table 6.1, exports have been increasing strongly in the new Member States, with 8.8% a year on average during the 1995-2006 period. Also in terms of sector value added, exports of the New Member States have grown substantially, as have imports, due to strong economic growth. As regards exports, we observe the same country grouping as with value added, with winners being Italy, Portugal, Spain, Czech Republic, Poland and Slovenia. Germany, Finland and Estonia are upcoming. The retreaters are, like value added, generally found in north-western Europe, and also in Greece, Hungary and Lithuania.

Table 6.1 Exports, export growth and exports as share of value added, 1995-2006

	Exports 2006	Average annual growth in exports 1995-2006	Exports as percentage of value added	Change in percentage of value added 1995-2006
	€ million	*%*	*%*	*%*
EU	58 150	3.2	67	6
EU 15	50 675	2.6	63	4
NMS	7 475	8.8	108	36
Winning	24 829	3.8	66	0
Losing momentum	6 964	1.9	111	10
Upcoming	13 108	7.9	83	37
Retreating	13 249	-0.1	49	-7

	Concentration >100	Concentration <100
Growth	***Winning:*** Italy, Portugal, Spain, Czech Republic, Poland, Slovenia	***Upcoming:*** Germany, Finland, Estonia
Decline	***Losing momentum :*** Belgium, Austria, Slovakia	***Retreating:*** France, Luxemburg, Netherlands, Denmark, Greece, Ireland, Sweden, United Kingdom, Hungary, Lithuania

Source: Eurostat/TNO data

Trade (exports and imports) data show that in general, while the trade balance is still positive, but is declining substantially for all EU Member States and across market segments as can be seen from Table 6.2. Especially for the EU-9 (the EU15 minus the founding fathers of the EU), the trade balance deteriorated, with a trade balance of nearly zero in 2006. In Germany, the trade surplus increased, that is, exports gained over imports. Overall in Germany comparative advantage increased; this increase can be assigned to higher capital intensity and efficiency (scale economies). In the new Member States, exports gained strongly, but imports grew at an even a faster rate.

Table 6.2 Imports, import growth, exports/imports ratio and change in ratio, 1995-2006

	Imports	Average growth rate *	Exports/imports ratio	Change of exports/imports ratio
	2006	1995-2006	2006	1995-2006
	m€	%	%	% points
EU	45 811	4.3	127	-15
EU 15	39 846	3.6	127	-15
NMS	5 965	10.9	125	-16

Source: Eurostat/TNO data

6.2 International competition

International competition has been mainly an issue for the manufacture of glass and ceramics. According to CEREMA-UNIE (2007), both industries have seen a dramatic erosion of their competitive position in recent years, which was expressed in a reduction of their external trade surplus. In the case of ceramics, this surplus was reduced from € 5 bn in 2003 to € 3.5 bn in 2006. According to ASCER (2005), the world-wide production of ceramics is concentrated in a few countries. China (32.5%) has come into the scene, followed by Spain (9.5%), Italy (8.7%), and Brazil (8.4%). Their cost advantages are formidable for other country manufacturers. For table glass, the EU industry competes with producers in China and Turkey whose raw materials are estimated to cost one-third, energy – one-fifth, and labour – one-tenth of the respective EU levels. Europe has traditionally been a global leader in the production of ceramic wall and floor tiles. However, it was rapidly overtaken in the 1990s when China started to increase its production capacity from 300 million m2 pa to 3 billion m2 in 2006, to the point where China now dominates world production (Ecorys, 2008). Imports from China present a growing challenge to the EU glass and ceramics industry, with imports having doubled recently, and possibly further growth ahead. The Chinese 'challenge' even includes, for instance, imports of (cement) clinkers with long distance transport via water having become more common. Worldwide, slightly more than 100 million tonnes of cement were moved for international trade by sea, approximately 6% of the total produced.

For building materials the combination of higher production costs due to the ETS and low transport costs could lead to a further increase in imports from other parts of the world (e.g. Northern Africa, Russia and China). However, a further decrease in transport costs in the medium and long term is not very likely because of rising global scarcity of oil; rather the opposite of an increase in transport costs might apply, even though in the current crisis transport costs are back at 2004-5 levels.

Specialisation in high-end niche markets may seem a solution, yet for how long? The high-tech applications of glass and ceramics also and already face international competition, which

is primarily based on quality and innovation. The UK, U.S., Germany, and Japan are the world's major producers of opto-electronics products (Hendry et al., 2000).

6.3 Trade issues

Trade in building materials other than ceramics (see above) is very small. Imported construction minerals cover only a small percentage of EU consumption, less than 1% by weight (EC, 2007). Exports of construction minerals are low as well. Only 0.6% of Europe's production is exported. Therefore trade issues are largely unimportant for this sector.

The situation is different for the manufacture of glass and ceramics. This industry feels it is facing *unfair competition* from the third country competitors both on the domestic and traditional export markets, and especially from China. A recent conference organized by the European Commission to address these issues made the following findings (European Commission, 2007). Foreign import tariffs on various glass and ceramics products are high. Ceramic hotelware sold to the U.S. faces import tariffs of 25% and to China – of 45%. Ceramic wall and floor tiles mainly face non-tariff barriers in the form of obligatory testing and certification systems in some of the major export markets like Ukraine, Egypt, Saudi Arabia, Mexico, and China. Similar EU imports tariffs are much lower than tariffs set by major competitors. For instance, they are about a half of those in China. However, trade agreements with India, Korea, and the ASEAN countries[8] offer *potential tariff and non-tariff barrier reductions* on glass and ceramics products and a regulation on origin marking ('made-in') for third country producers that sell on the EU market. State price supports (notably China) are another threat and distort the level playing field.

European ceramics tableware producers have also been complaining for years about imported products *copied from European designs (counterfeiting)*. More recently, there have been similar complaints from glass tableware manufacturers in relation to trademark infringements. The Commission has simplified the procedures for the seizures of suspect *counterfeit goods* at the point of entry but so far no tableware producers have applied for these to put into effect. On the other hand, the industry has supported the recently introduced *mark of origin* to allow customers to make an informed purchase decision and to reduce the incidence of fraudulent or misleading indications which would undermine the reputation of EU producers. However, there is a growing pressure from the industry on the EU to employ trade protection (trade defence) measures, including safeguarding and anti-dumping measures, and in addition action on origin marking, and adequate action to prevent counterfeiting, with both producers and traders to be punished.

Current CO2 quota arrangements in relation to changes due to the new CO2 Emission Trading System (ETS) will impact trade, and might negatively affect exports from the new Member States being increasingly substituted by imports from other countries.

6.4 Externalisation strategies – outsourcing and offshoring

On the aggregate level, the ceramics industry has seen a substantial decline in its workforce and number of employers as a result of consolidation (mergers), plant closures, technological change, organisational restructuring, and outsourcing over time (Caroll et al., 2001).

[8] Including the Philippines, Malaysia, Singapore, Thailand, Indonesia, Brunei, Vietnam, Laos, Myanmar, and Cambodia.

Nonetheless outsourcing and offshoring strategies have not been extensively studied. Based on a case study of the ceramics industry in Stoke-on-Trent, the UK, Caroll et al. argue that outsourcing strategies are mainly limited to the subcontracting of production capacity (which is short-term and unstable, set-up purely to meet unexpected or exceptional increases in demand) or economic subcontracting (which targets cost benefits obtained by subcontracting out), whereas long-term specialised subcontracting with the goal to access specialised expertise or technology that is not available in-house does not take place. These trends are primarily fuelled by global competition and tightened cost structures in Europe.

Delocalisation in ceramics has recently become a more serious concern with the introduction of the ETS (Emissions Trading Scheme). The ETS is likely to raise energy (gas) prices, and have an strong upward effect on production costs, possibly leading to a reduction of investment levels in firms located in the EU. Delocalisation (offshoring) could occur towards areas where such environmental standards do not apply (e.g. Russia, China). For SMEs, such delocalisation would not be option (Ecorys, 2008). Delocalisation impacts of the introduction of the EU Emission Trading System may go even further and may occur in the construction materials industry as well, notably in lime and cement (see further chapter 7). Carbon leakage is considered to be a serious problem. ETS hence may lead to (more CO2 prone) imports and loss of EU competitiveness, and eventually jobs.

Box 2. Defining and measuring relocation and outsourcing

One of the biggest challenges when analysing and discussing offshoring and outsourcing is the definitional issue of what precisely is meant and - closely related – how to measure the phenomenon. Outsourcing covers activities previously carried out in-house sourced to third parties whether abroad or in the home country. Offshoring in its strictest sense relates to activities being discontinued in the home country and transferred to a location abroad managed within the same entity or by an affiliated legal entity (OECD, 2007). Frequently, the political debate mixes the above three and also discusses job losses due to restructuring unrelated to offshoring under the same label. Furthermore, the political debate is fuelled by estimates which are the main source of evidence in the absence of hard statistics. Two broad sources on job relocation have as a result emerged: private consulting estimates and press monitoring estimates (Van der Zee et al., 2007). While consulting estimates have severe limitations (ibid), the estimates collected by press monitorings such as the ERM are more reliable. The most valid data, however, systematic official statistics on the employment impact of relocation, are not collected anywhere in the world today. As a result, academics who nevertheless want to use official statistical data resort to proxies of indicators of relocation activity, such as trade data, FDI flows and input–output tables (Van der Zee et al., 2007). However, these indicators only measure the indirect effects of relocation and are affected by a number of other factors making hard conclusions difficult to draw.

7 Regulation

Regulation is a very prominent issue for both the glass and ceramics and building materials sector. These industries are both energy- and material-intensive which makes them sensitive to environmental and energy-related regulatory issues. The possible impact of the current WTO Doha Round on trade liberalisation as well as the future of environmental regulation in the EU and outside (i.e. competitors) are important drivers of change for the industry.

Regulation can, if properly defined and targeted, also act as an important driver of innovation, for instance to reduce energy use, recycling and re-use.

As reported in European Commission (2007), the principal issues of concern to both the glass and ceramics industry and the building materials industry are the rising costs of energy, compliance with the EU Greenhouse Gas *Emission Trading System (ETS)*, the implementation of *Integrated Pollution Prevention and Control (IPPC)* (Directive 96/61/EC), and the classification of substances with *REACH* (Regulation Concerning the Registration, Evaluation and Authorisation of Chemicals). The aim of IPPC is to prevent or reduce pollution of the atmosphere, water and soil, as well as the quantities of waste arising from industrial and agricultural installations to ensure a high level of environmental protection. The Directive sets 'mandatory environmental conditions' that must be met in order for a permit to be issued. This includes, for instance, the requirement to adopt the Best Available Technique (procedures and methods that produce the least waste, use less hazardous substances, enable the recovery and recycling of substances generated) and efficient energy use. The IPPC Directive is by the EU glass industry taken up by actively encouraging glass recycling, and where possible using recycled glass (cullet) in production (e.g. Ecorys, 2008a). Pollution prevention has led existing installations to having been brought into compliance by October 2007.

The administrative costs of REACH are assessed to be extremely high by some parts of the industry. For the glass and ceramics sub-sectors which are mainly downstream users, REACH requirements are lighter than for other producers.

The lime and cement industry, for instance, are strongly affected, as the (potential) costs of CO2 under the current ETS arrangements are considerable. For example, estimates for the manufacturing lime industry show that full-auctioning at €25/tonne of CO2 will result in an increase of up to 51% of lime production's marginal costs in the EU. At prices of €30/tonne, lime production costs (raw materials production costs) would even increase by more than 50% on average, making CO2 the most important single cost item in lime production (European Lime Association, 2008). The manufacture of cement is assessed to be the most carbon-intensive of all sectors covered by the EU ETS, with on average 0.75 tCO2 emitted per tonne of cement produced. Emissions from the sector totalled 179 MtCO2 in 2006, or 8.6% of the total emissions covered by the EU ETS. After lime, the cement sector is the most cost-sensitive sector covered by the EU ETS, measured in terms of carbon intensity relative to revenue. At present high transport costs keep production fairly localised and imports account for just 8% of the market. With the added cost of EU ETS compliance, however, there was a risk that production would shift overseas, and in fact imports from outside the EU have increased by almost 4% year on year since 2005. Research has suggested that a carbon price of €20-30 would be enough to cover international transport costs, except to inland areas (IDEAcarbon, 2008). The Boston Consulting Group (Euractiv, 2008) estimates that clinker and cement production in the EU will be seriously affected by carbon leakage, and that as a consequence, relocation of clinker production to countries with no carbon constraints will accelerate from 2013 and will continue in the following years. With full auctioning in 2020 and at CO2 prices of € 35 per tonne, all integrated clinker – cement production in the EU would be wiped out of the EU leading to a loss of approximately 40,000 direct jobs and € 4.2 billion gross value added (GVA) per year (ibidem).

The main concern of the ceramics and glass sector is the upward impact of the ETS on gas prices, feeding into operating costs and decreasing profitability, as well as the uncertainty created by the long decision period in re-evaluating the ETS makes decision-making within

the sector difficult, possibly leading to reduction of investment and delocalisation (Ecorys, 2008). Projections for the UK container and glass sub-sector show a three to four-fold increase in direct CO2 purchase costs over 2013-20). The relatively high energy intensity of glass production makes the challenge of reducing carbon dioxide emissions especially demanding, as technologies used in glass production to minimise energy use are already mature and that short-term future increases in efficiency are likely to be limited. One way the industry is reacting is by using increasing amounts of recycled glass in production (Ecorys, 2008a). Recycling, by the way, is regulated by the new EU Waste Framework Directive (WFD – Directive 2008/98/EC).

IPPC, ETS and REACH form a major cost component for the glass, ceramics and construction materials sub-sectors and create a number of competitive challenges for the EU. The fact that other countries have fewer production constraints and lower production costs is especially a threat to the producers of mass produced low cost products. For instance in glass especially container glass and domestic glass producers and producers with high emissions per ton glass, e.g. lead crystal glass, are affected (e.g. Ecorys, 2008). Environmental regulation also, and particularly, affects SMEs which face more challenges to meet the workload and short time frames set by the regulations.

A number of regulations relate to *working conditions*; they mostly refer to the handling of input materials, i.e. the way they are stored, handled and used in production. In the glass industry legislation regulating lead concentration and hazardous substances require conversions in the production and stricter control of input materials. These regulations are significant, as the industry, especially the domestic glass industry, is labour intensive. Less strict regulation in other countries leads to consequently lower production costs.

In particular the glass and ceramics industry have to take account of *consumer health and safety regulations and standards*, including the December 2006 regulation on the good manufacturing practice for materials and articles that come into contact with food (Regulation 2023/2006/EC, see below), and regulations applying to construction. The construction sector is also subject to other forms of regulation dealing with energy efficiency, climate change, pollution, etc. Traditionally the construction sector has been heavily dependent on government, which has acted both as a customer (amongst others through a long tradition of social house building) and a regulator. Technical regulations generally determined the housing production and created limited opportunities for product variation in building materials (Pries and Janszen, 1995). The deregulation of the building market, being an important end-market, has led to a demand for a wider variety of products (Voordijk, 2000). The objective to improve the energy efficiency of the building stock creates promising opportunities for the building material industry (e.g. through advanced technology glazing products, insulating fibre glass and brick products). Recyling and re-use of materials, as already mentioned in chapter 5, could further improve efficiency and add to sustainability, and might be targeted further by regulatory activity.

A more exhaustive account by Ecorys (2008a) for the glass sector shows how regulations may differ from sub-sector to sub-sector, and even beyond ("sub-sub"sector):

- domestic glass: Regulation concerning lead content in crystal glass; Regulation for materials intended for contact with food
- container glass: Regulation for materials intended for contact with food; Packaging regulations

- insulation glass fibres: Regulation concerning construction products; Regulation concerning retrofitting housing to tackle climate change; Building regulations on safety

- reinforcement glass fibres: Regulation concerning construction products; Building regulations on safety; Restriction of hazardous substances in electrical and electronic equipment; Regulation of the technical requirements for the treatment of end-of-life vehicles

- special glass: Restriction of hazardous substances in electrical and electronic equipment; Regulation of the technical requirements for the treatment of end-of-life vehicles; Eco-design requirements for energy-using products

- flat glass: Regulation concerning construction products; Regulation on higher energy efficiency of building products; Regulation of the technical requirements for the treatment of end-of-life vehicles.

Intellectual Property Rights (IPR) are increasingly important as the EU is confronted by massive counterfeiting (e.g. in tableware ceramics, wall and floor tiles, domestic glass). A stronger enforcement of IPR could restore some of the lost competitive position of EU products. The current Directive allows stronger enforcement, covering infringements of all intellectual property rights (copyright and industrial property such as trademarks or designs). Another crucial Directive to specialisation in high value and niche products the design protection is the Design protection Directive (e.g. by origin marking).[9]

Rules of the game; framework conditions; policy formulation and implementation. Apart from regulation in the stricter sense, the EU and its Member States have an important role to play in setting the rules of the game, in promoting an attractive business climate and competitive environment (level playing field), and in putting in place adequate ('right') framework conditions, or more broadly defined, in formulating, implementing and enforcing policies.

Raw Materials Initiative. In this wider context, it should be mentioned that the European Commission has recently launched with the *Raw Materials Initiative* an integrated strategy to ensure that European industry has fair access to the raw materials and does not suffer from a competitive disadvantage over companies based in resource-rich countries. Adopted in November 2008, the initiative encompasses measures in three areas to secure sustainable supplies of the materials needed for the EU economy: 1) ensuring fairer access to supplies from outside Europe (and addressing discrimination), 2) improving conditions for mining minerals within Europe, and 3) increasing the recycling of such materials. Apart from 'traditional' metals such as copper, aluminium and iron, the initiative also includes minerals such as potash, silica and salt, and aggregates – sand, gravel, cement – used in construction.

Raw materials account for around one fifth of total manufacturing costs in ceramics and more and more raw materials are imported into the EU. Moreover, the sector is in competition for raw materials with other sectors and rising prices will be a challenge to sector competitiveness of the sector, especially in sub-sectors where end-users can substitute ceramics products with other materials. The refractory sub-sector is highly dependent on imported high-quality raw materials found in very few places in the world. This includes high quality magnesia (90% of

[9] Directive 98/71/EC on the legal protection of designs, and Directive 2004/48/EC on the enforcement of intellectual property rights.

high-purity magnesia coming from China), bauxite (high-quality bauxite coming from in Guyana, but nowadays controlled by Chinese companies), and graphite (e.g. Ecorys, 2008).

8 SWOT analysis

SWOT analysis is a tool in management and strategy formulation, used to evaluate the Strengths, Weaknesses, Opportunities, and Threats involved in a project, business venture or – as in this case – a sector, the latter being defined within a well-described geographical entity. The aim of a SWOT analysis is to identify the key internal and external factors that are important to achieving a particular objective or set of objectives. Strengths and weaknesses are internal factors that create or destroy value. For a company these can include assets, skills or resources that a company has at its disposal, compared to competitors. Opportunities and threats are external factors that create or destroy value. They emerge from either the company dynamics of the industry/market or from demographic, economic, political, technical, social, legal or cultural factors (STEEP or DESTEP, see also chapter 9). When applied to the sector level, SWOT has a similar meaning, albeit on a higher, more aggregated level.
The SWOT analyses presented in tables 8.1 and 8.2 are the result of an intensive workshop discussion which was subsequently validated and amended in two external workshops, including the final workshop in Brussels (step 10 in the methodological framework). The glass and ceramics SWOT was further adjusted and refined on the basis of two recent studies on the glass and the ceramics sector (Ecorys 2008; Ecorys, 2008a). Table 8.1 presents the SWOT analysis for the sub-sector building materials. Building materials is a mature sector with well established markets. International competition so far has affected it only minimally, but competition from the BRICs and other emerging economies is building up here as well. Like the glass and ceramics sector production is characterised by energy intensive production process which makes it vulnerable to increasing scarcity of and hence upward price movements of energy (oil, gas, electricity). Opportunities for the sector include technological progress leading to new materials (lightweight, energy efficient) and increased efficiency through industry consolidation. At the same time, limited domestic and international competition often leads to inefficiencies. The sector is vulnerable to rising energy and material prices. The building materials sector has increasing difficulties in attracting qualified personnel due to image problems and changing preferences regarding shift work and long work days.

Table 8.1 SWOT construction materials

Strengths	**Weaknesses**
• High demand for materials • Mature industry with constant technological progress • High quality products	• High energy intensity • Conservative industry • High transport cost over land • Increasingly subject to competition internationally due to low sea transport costs (also in bulky, low value goods) • Low domestic ('within-EU') competition
Opportunities	**Threats**
• Increased efficiency through industry consolidation; • Recycling and re-use • Energy use reduction; energy-saving technology • Fair(er) and secure access to raw materials (Raw Materials Initiative) • Increasing substitution of raw materials • Establishing firm supplier relationships for the longer term (energy and raw materials) • Changing consumer preferences for sustainable materials (eco-housing) • Growing importance DIY (do-it-yourself) market demand, also driven by increasing second home market • Technological advances leading to new materials (lightweight, energy efficient) New product/ new market opportunities, related to R&D and innovation (e.g. nanomaterials)	• Tighter environmental regulations (IPPC, ETS, REACH) and associated production cost increases as compared to competitors, especially in the cement and lime industries • Lifestyle changes and work-leisure balance (preference shift away from long hours and shift work leading to recruitment problems) • Image problems (heavy and dirty industry) in relation to recruitment • Rising energy and raw material prices and increasing scarcity of certain rwa materials • Changing consumer preferences for sustainable materials.

Source: TNO/SEOR data

Table 8.2 SWOT glass and ceramics

Strengths	**Weaknesses**
• High demand for (new) products and materials • Mature industry with rapid technological progress, high capital intensity and economies of scale, with several large EU-based companies (glass) and flexible and innovative SMEs (ceramics) • New technology in production and automation (ceramics) • High quality products • Strong international reputation for quality, design and innovation (glass and ceramics) • Trained and skilled labour force (esp. glass) • Knowledge clusters of SMEs (ceramics), which stimulate R&D, innovation and knowledge transfer, and also provide a source of skilled and experienced workers.	• High energy intensity (ceramics) • Mature production process close to limits and industry's capacity to improve efficiency and further reduce CO2 (glass) • High labour cost (for some sub-sectors) • High capital intensity and high sunk costs → high entry barriers (glass and ceramics) • Vulnerability to demand shifts due to high specialization • Long investment cycle in combination with high investment (glass) • Low production flexibility in capacity utilisation (refractory ceramics and brick and floor tiles) • Image, low attractiveness to high-skilled and technical personnel
Opportunities	**Threats**
• Fair(er) and secure(r) access to raw materials (cf Raw Materials Initiative) • Establishing firm supplier relationships for the longer term (both energy and raw materials) • Cleaner and energy-saving technologies (ceramics) • Further consolidation (M&As) and integration of the value chain in combination with automation to increase productivity (glass) • Growing demand for new materials in high-tech industries and innovative applications (ceramics, glass), with new markets ahead, and hence a premium to R&D and innovation • Promoting glass as energy friendly product (glass: low-e and solar glazing, solar panels, insulation products, fibre for light weighting, low-energy long-life bulbs, recyclable packaging) • Substitution of other products such as wood and metals by glass fibres (light weight) • Growing market demand due to socio-economic changes (income, demographics, eco-trends) and new forms of trade (via Internet) • New export opportunities in high growth emerging economies (e.g. BRICs) • Brand and loyalty; trade marking (ceramics) • Improvement of services (just-in-time and time-to-market: ceramics) • Flexibility, customisation, and personalisation (ceramics) • Stronger IPR legislation (EU-wide as well as stronger enforcement)	• Tighter environmental regulations (and mostly one-sided EU measures) • Rising energy and raw material prices, and future scarcity/shortages of supplies • International competitive pressures and low-cost competition in glass and ceramics (China) • Energy scarcity and prices (ceramics) • Substitution by other products (ceramics: in combination with weight, e.g. floor and wall tiles against carpets or painting; glass: plastic steel, aluminium, carton in container and domestic glass) • Trade barriers in third countries • Counterfeiting (fine ceramics: tableware and wall and floor tiles; glass: container glass and domestic glass) and lack of IP protection (esp. expensive for SMEs) • Lifestyle changes and work-leisure balance (preference away from long work days, shift work) • Declining availability of craftsmen (some sub-sectors, esp. ceramics) in combination with ageing and a declining number of students in higher education

Source: TNO/SEOR data and Ecorys (2008;

Table 8.2 presents the SWOT analysis for the sub-sector glass and ceramics. Glass and ceramics are mature industries with rapid technological progress which produce high-quality

products and have a good international reputation for quality. Their production is characterised by the transformation of naturally occuring minerals such as limestone and silica, and clays, through an energy intensive process (especially in ceramics) which makes them vulnerable to increasing scarcity/price increases in energy. New opportunities for the sub-sector arise from growing demand for high-tech ceramics, growing market demand at home (DIY, second homes) and new export opportunities for high-quality products in high-growth economies. However, the sector is vulnerable to competitive pressures from (low-wage) emerging economies and energy prices. In addition, the sub-sector experiences shortages of qualified labour (craftsmen) in the handicraft segment, as well as increasing difficulties in attracting personnel in the bigger companies due to image problems and changing preferences regarding shift work and long work days.

9 Drivers

9.1 Identification of sectoral drivers: methodology and approach

The methodological framework as defined by Rodrigues (2007) serves as the starting point for the identification of drivers. Rodrigues identifies three main driver categories: economic, technological and organizational drivers, with the economic dimension representing the main trends in demand and supply, the technological dimension covering the main trends in process and product innovation (including services) and the organizational dimension representing main trends in job functions (conceptual, executive). The Rodrigues' approach in principle enables the identification of drivers, and especially so at the meso (sector) and micro (firm or company) level. The search and identification procedure of drivers itself is less well defined, however. Implicitly it is assumed that expert opinion and desk study are sufficient tools to come up with a relevant and plausible set of drivers at the sector level.

During the first stage of the project, a methodological tool (approach) has been developed to facilitate and help the identification and further delimitation of drivers, to arrive at a set of key drivers. Apart from expert opinion mobilised and managed as discussion panel (in a similar manner as a SWOT analysis is usually organised), this approach strongly builds on the findings of existing foresight and other future studies. By consistently linking the search for drivers with the findings in existing foresight and other future studies, a more coherent and all-embracive methodology to finding sector-specific drivers can be deployed.[10] This so-called 'meta-driver' approach of identifying main sectoral drivers starts from a more generic list of meta-drivers derived from a literature survey, and subsequently in a step-wise manner delimits the drivers to a set of most relevant and credible drivers. It does so by combining adequate expert (sector) knowledge in a panel setting. By subsequently asking the expert panel to score the different drivers on a range of characteristics, including relevance, uncertainty, and expected impact (similar to a SWOT procedure), a corroborated and conclusive list of sector-specific drivers can be derived. The meta-driver approach hence enables filtering out in a systematic and consistent way meso and possibly micro (sector-specific) as well as the macro (economy-wide) trends and developments judged relevant and important to the sector, directly and indirectly.

[10] Common ways to rank trends and drivers are the DESTEP (Demographic-Economic-Social-Technological-Ecological-Political) and STEEP (Social-Technological-Economic-Ecological-Political) categorisations. For our purpose, slightly altered DESTEP definitions are used to reflect the embracing dimension of analysis.

The meta-driver approach includes the following five steps:

Step 1. Drawing up of a list of relevant generic or meta-drivers based on literature review and expert knowledge (check-list: rows)
Step 2. Designing a list of key questions in order to identify the sector relevance and other properties of meta-drivers at sector level (check-list: columns)
Step 3. Filling in the check-list matrix: which meta-drivers do matter most for the sector?
Step 4. Which drivers do matter most for jobs and skills?
Step 5. Does the tailor-made list herewith cover all relevant sectoral drivers, i.e. are there any sector-specific drivers missing (check on completeness)

Arguments in favour of the use of the 'meta-driver' approach are:

- The ability and opportunity to use the rich potential of a multitude of already available studies on drivers, determinants of change and key trends
- Circumventing the risk of a too narrow focus on the sector per se while acknowledging sector-specificity, and avoiding the risk of analyzing sectors as if they were isolated (cf the difference between 'general equilibrium' and 'partial equilibrium' approaches)
- Guaranteeing overall consistency, coherence and completeness, as well as warranting a same point of departure important across lots/sectors – i.e. a way of integral assessment, making sure that all important factors are systematically taken on board.

An alternative and second way to arrive at a list of main sector-specific drivers of change is to start with a SWOT and subsequently translating the Opportunities and Threats part into sector-specific drivers. The SWOT is used as a tool to verify and check the resulting list of drivers. By combining the results of both the "from meta-drivers to sector-drivers" and the "from SWOT to sector-drivers" exercises a complete and consistent list of sector-specific drivers can be derived.

9.2 Sectoral drivers: discussion

In total 26 drivers falling in the six DESTEP (demographic, economic, social, technological, environmental and political) were assessed for the glass and ceramics sub-sector (see Table 9.1) and the construction materials sub-sector (Table 9.2).[11] For each of the drivers, the following questions were posed and a common expert position (i.e. answer) reached:

- Is this driver relevant for the sector? Yes (Y) / No (N)
- How relevant is this driver for the sector? Scale 0-10 10 (0=not relevant; 10= very relevant)
- How uncertain is this driver for the sector? Scale 0-10 (0=very certain; 10= very uncertain)
- Are substantial impacts expected on the volume of employment? Y/N
- Are substantial impact expected on employment composition? Y/N

[11] It should be noted that the DESTEP analysis and workshop was held in late Spring 2008, i.e. *before* the financial and economic crisis. Further validation took place in another workshop in August 2008 and during the final workshop in early November 2008.

- Are substantial impacts expected on new skills? Y/N, with a distinction to short (S: = 0-3 years), medium (M:= 3-7 years; or long (L:= > 7 years) run impact
- Are substantial differences expected between (groups of) countries? Y / N
- Are substantial differences expected between sub-sectors? Y / N.

Table 9.1 Sector-specific drivers: glass and ceramics sub-sector

Category	Driver	Is this driver relevant for the sector? Y / N	How relevant is this driver for the sector? Scale 0-10	How uncertain is this driver for the sector? (0: very certain; 10: very uncertain) Scale 0-10	Are substantial impacts expected on the volume of employment? Y/N	Are substantial impact expected on employment composition? Y/N	Are substantial impacts expected on new skills? Y/N	Short, medium or long run impact?[12] S	M	L	Are substantial differences expected between (groups of) countries? Y / N[13]	Are substantial differences expected between sub-sectors? Y / N
Demographic	Ageing - Adapt to the market demands of an ageing and more diversified society	N										
	Ageing – declining labour force	Y[14]	2	1	Y	Y	Y	Y	Y	Y	Y	Y
	Population growth (birth and migration)	Y	6	3	Y	Y	N	Y	Y	Y	Y	N
Economic	Income per capita and household	Y	6	4	Y	Y	N	Y	Y	Y	Y	N
	Income distribution	Y	6	4	Y	Y	N	N	Y	Y	Y	Y
	Outsourcing & offshoring	Y	3	2	Y	Y	Y	Y	Y	Y	Y	Y
	Increasing global competition	Y	9	2	Y	Y	Y	Y	Y	Y	Y	Y
	Emerging economies driving global growth (new market demand, especially BRICs[15])	Y	3	2	Y	Y	Y	Y	Y	Y	Y	Y
	Global / regional production networks (dispersed production locations, transport)	N										
	Counter-trend regionalism / protectionism	Y	6	7	Y	N	N	Y	Y	Y	Y	Y

[12] Short = 0-3 years; medium = 3-7 years; long = > 7 years. All three categories may apply.
[13] If necessary include footnote in cell with more precise info what differences are.
[14] For the labour intensive, handicraft and customized part of the market (e.g. decoration).
[15] BRIC countries: Brazil, Russia, India, China.

Category	Driver	Is this driver relevant for the sector?	How relevant is this driver for the sector?	How uncertain is this driver for the sector?	Are substantial impacts expected on the volume of employment?	Are substantial impact expected on employment composition?	Are substantial impacts expected on new skills?	Short, medium or long run impact?			Are substantial differences expected between (groups of) countries?	Are substantial differences expected between sub-sectors?
		Y / N	Scale 0-10	Scale 0-10	Y/N	Y/N	Y/N	S	M	L	Y / N	Y / N
Social / cultural	Increasing market segmentation (tailor made production, mass customization)	Y	5	6	N	Y	N	N	Y	Y	Y	Y
	Lifestyle changes (consumers)	Y	3	7	N	Y	N	N	N	Y	Y	Y
	Lifestyle changes (workers, preferences for shift work, etc)	Y	8	3	N	Y	N	Y	Y	Y	Y	Y
	Increasing demand for environmentally friendly / eco-products	Y	6	5	N	Y	N	N	N	Y	Y	Y
Technological	Advances in IT impacting on organizational structures & new business models	Y	4	2	N	Y	Y	Y	Y	Y	Y	Y
	Internet changing production and consumption patterns (e-business; etc.)	Y	6	3	N	Y	Y	Y	Y	Y	N	Y
	New types of work organisation (teams-based, sociotechnique, etc.)	N										
	Automation, robotisation	Y	8	2	Y	Y	Y	Y	Y	Y	Y	Y
	New/additional value-added services (flexibility and speed)	Y	6	5	N	N	N	N	N	N	N	N
	Other: new materials, new applications	Y	8	3	Y	Y	Y	Y	Y	Y	Y	Y
Environmental	Availability (and price developments) of oil and energy (due to energy-intensity)	Y	8	4	Y	N	N	Y	Y	Y	N	N
	Availability and price of raw materials	Y	8	4	Y	N	N	Y	Y	Y	N	N
	Substitution, recycling, re-use	Y	5	3	N	N	N	N	N	N	N	N

Category	Driver	Is this driver relevant for the sector?	How relevant is this driver for the sector?	How uncertain is this driver for the sector?	Are substantial impacts expected on the volume of employment?	Are substantial impact expected on employment composition?	Are substantial impacts expected on new skills?	Short, medium or long run impact?			Are substantial differences expected between (groups of) countries?	Are substantial differences expected between sub-sectors?
		Y / N	Scale 0-10	Scale 0-10	Y/N	Y/N	Y/N	S	M	L	Y / N	Y / N
Political / regulatory	Trade and market liberalisation (national level)	N										
	EU integration – deepening (single European market etc.)	N										
	EU integration – broadening (bigger domestic market)	N										
	Quality of institutions (judiciary, transparency, lack of corruption, viable business climate, structural rigidities)	N										
	Intellectual property rights (IPR) protection / counterfeiting	Y	8	6	Y	Y	N	Y	Y	Y	Y	Y
	Environmental regulation (IPPC, REACH, ETS)	Y	8	2	Y	Y	Y	Y	Y	Y	Y	N
	Safety, health and security regulation (both relating to consumers and workers)	Y	8	2	Y	Y	Y	Y	Y	Y	Y	Y

Table 9.2. Sector-specific drivers: Construction materials sub-sector

Category	Driver	Is this driver relevant for the sector?	How relevant is this driver for the sector?	How uncertain is this driver for the sector?	Are substantial impacts expected on the volume of employment?	Are substantial impact expected on employment composition?	Are substantial impacts expected on new skills?	Short, medium or long run impact?			Are substantial differences expected between (groups of) countries?	Are substantial differences expected between sub-sectors?
		Y / N	Scale 0-10	Scale 0-10	Y/N	Y/N	Y/N	S	M	L	Y / N	Y / N
Demographic	Ageing - Adapt to the market demands of an ageing and more diversified society	N										
	Ageing – declining labour force	N										
	Population growth (birth and migration)	Y	8	2	Y	N	N	Y	Y	Y	Y	Y
Economic	Income per capita and household	Y	8	4	Y	N	N	Y	Y	Y	Y	Y
	Income distribution	Y	6	4	Y	N	N	Y	Y	Y	Y	Y
	Outsourcing & offshoring (cement, lime industries)	Y	6	6	Y	Y	N	N	Y	Y	Y	Y
	Increasing global competition	Y	8	4	Y	Y	Y	Y	Y	Y	Y	Y
	Emerging economies driving global growth (new market demand, especially BRICs)	Y	5	5	Y	Y	N	Y	Y	Y	N	Y
	Global / regional production networks (dispersed production locations, transport)	N										
	Counter-trend regionalism / protectionism	N										
Social / cultural	Increasing market segmentation (tailor made production, mass customization)	N										
	Lifestyle changes impacting on work preferences (less shift work, less long working days)	Y	7	3	Y	N	N	Y	Y	Y	Y	

Category	Driver	Is this driver relevant for the sector?	How relevant is this driver for the sector?	How uncertain is this driver for the sector?	Are substantial impacts expected on the volume of employment?	Are substantial impact expected on employment composition?	Are substantial impacts expected on new skills?	Short, medium or long run impact?			Are substantial differences expected between (groups of) countries?	Are substantial differences expected between sub-sectors?
		Y / N	Scale 0-10	Scale 0-10	Y/N	Y/N	Y/N	S	M	L	Y / N	Y / N
	Increasing demand for environmentally friendly products; eco-construction materials	Y	6	4	N	N	N	Y	Y	Y	Y	Y
	Image and attractiveness - dirty and heavy industry image reducing recruitment potential, esp. amongst certain worker categories (e.g. women)	Y	7	3	Y	Y	N	Y	Y	Y	Y	N
Technological	Advances in IT impacting on organizational structures & new business models	Y	2	2	N	N	N	Y	Y	Y	N	N
	Internet changing production and consumption patterns (e-business; etc.)	Y	4	2	N	N	N	Y	Y	Y	N	N
	New types of work organisation (teams-based, sociotechnique, etc.)	Y	2	2	N	Y	N	Y	Y	Y	N	N
	New/additional value-added services	N										
	New products / materials (more lightweight, energy efficient, eco-materials)	Y	6	6	N	N	N	Y	Y	Y	Y	Y
	Other (Energy efficient technology, e.g. furnaces; labour saving technologies)	Y	6	2	Y	Y	Y	Y	Y	Y	N	Y
Environmental	Availability (and price developments) of oil and energy	Y	8	5	Y	N	N	Y	Y	Y	N	N
	Availability and price of raw materials	Y	8	5	Y	N	N	Y	Y	Y	N	Y
	Substitution raw materials and energy, recycling and re-use	Y	7	5	Y	N	N	Y	Y	Y	N	Y

Category	Driver	Is this driver relevant for the sector?	How relevant is this driver for the sector?	How uncertain is this driver for the sector?	Are substantial impacts expected on the volume of employment?	Are substantial impact expected on employment composition?	Are substantial impacts expected on new skills?	Short, medium or long run impact?			Are substantial differences expected between (groups of) countries?	Are substantial differences expected between sub-sectors?
		Y / N	Scale 0-10	Scale 0-10	Y/N	Y/N	Y/N	S	M	L	Y / N	Y / N
Political / regulatory	Trade and market liberalisation (national and EU level)	N										
	EU integration – deepening (single European market etc.)	N										
	EU integration – broadening (bigger domestic market)	N										
	Quality of institutions (judiciary, transparency, lack of corruption, viable business climate, structural rigidities)	N										
	Trade liberalisation (WTO Doha)	Y	8	8	Y	N	N	Y	Y	Y	Y	Y
	Environmental regulation (both inside and outside EU)	Y	9	4	Y	N	Y	Y	Y	Y	Y	Y
	Safety and security regulation (customers and workers)	Y	8	2	N	N	N	Y	Y	Y	Y	Y
	Health regulation (customers and workers)	Y	8	2	N	N	N	Y	Y	Y	Y	Y

Part II.

Future Scenarios and Implications for Jobs, Skills and Knowledge

Part II. Future Scenarios and Implications for Jobs, Skills and Knowledge - Guide to the reader

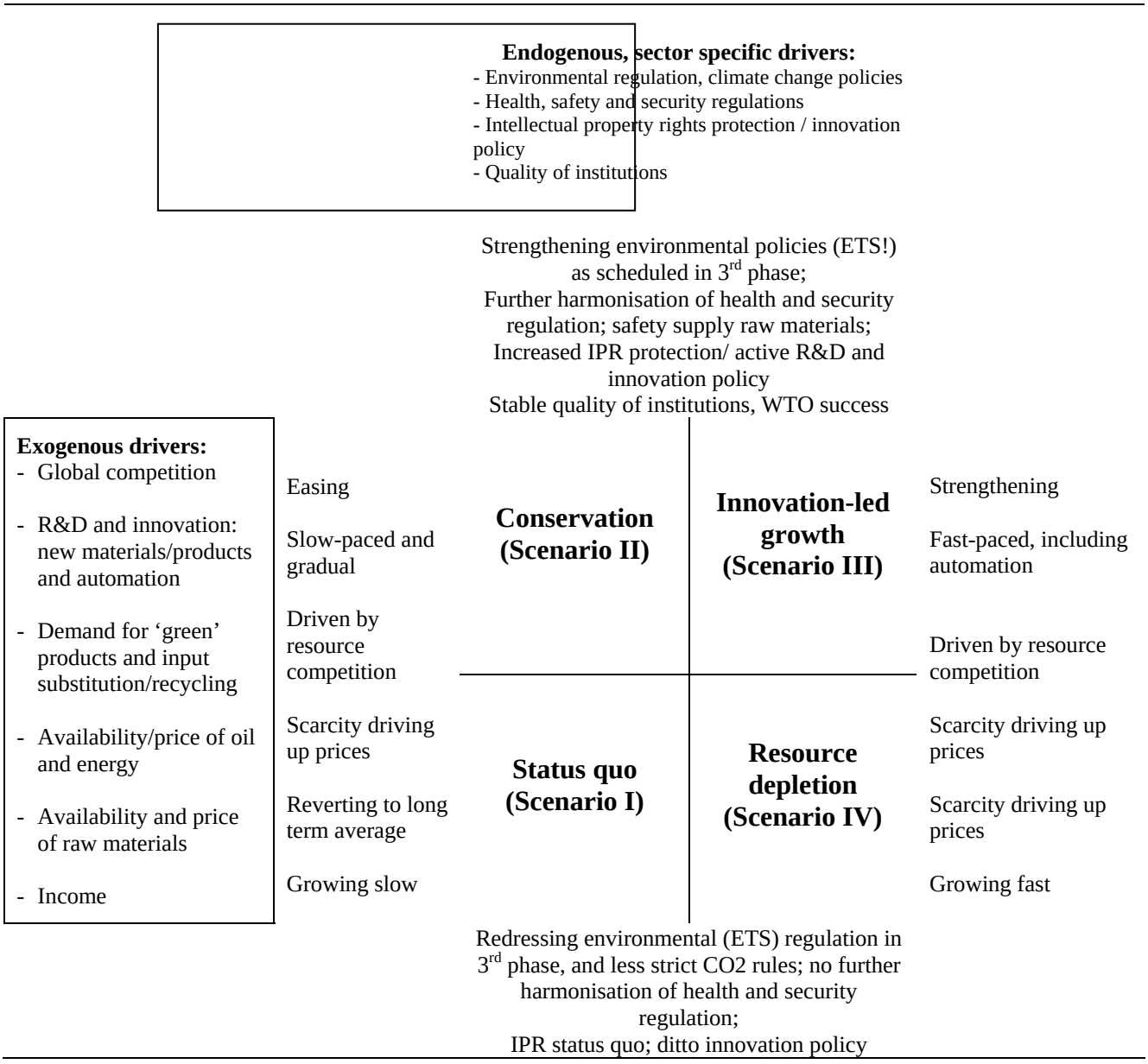
Part II presents the scenarios and their implications for jobs, skills and knowledge. It reflects steps 4, 5 and 6 of the common methodology. The contents of part II are as follows: Chapter 10 describes the structure and highlights the content of the four main scenarios (step 4). For each of these scenarios plausible yet different assumptions have been made as to how the main drivers of change will develop and add up to different states of the future. In subsequent steps the implications of the scenarios for jobs and skills are analysed. In order to facilitate a translation of these implications to the job function level, first a workable job function structure is proposed in Chapter 11. This structure is based on the functions as they appear in Eurostat's Labour Force Survey and further elaborated. Chapter 12 discusses the main implications of the scenarios in terms of future employment volumes by job function (step 5). Chapter 13 assesses the implications of scenarios for future skills and knowledge needs by job function. It translates the implications of the scenarios for skills and knowledge by function (step 6).

10 Scenarios

10.1 Overview of scenarios and main underlying drivers

This section presents the main scenarios for the non-metallic materials sector. The scenarios take a medium-long range time perspective, taking 2020 as the focal year. The scenarios which were specifically constructed for the sector in this study are based on a clustering of relevant drivers identified in part I. Figure 10.1 summarizes the scenarios and highlights the underlying drivers, with the x-axis reflecting the relevant exogenous drivers and the y-axis reflecting the relevant endogenous drivers.

Figure 10.1 Four future scenarios for the non-metallic materials sector and main underlying drivers



The scenarios are construed to 'scan' the future, and are for the purpose of this study used to assess the impact of future developments on jobs, skills and knowledge. It is important to understand what scenarios can deliver and what not. Scenarios depict plausible futures and might reveal possible paths of development towards these futures. They are neither predictions or forecasts, nor wishful pictures ('dreams', 'crystal ball gazing') of the future. Grounded in existing data and trends, scenarios are derived in a logical and deductive way, with different and sometimes opposing presumptions about how key drivers might develop, resulting in inferences about plausible, i.e. credible and imaginable, futures.

10.2 The drivers – building blocks for scenarios

For the glass and ceramics sub-sector, the following main drivers have been identified (rated at 8 and 9, see chapters 8-9):

- Global competition
- Trade liberalisation/WTO;
- Availability and price of oil and energy;
- Availability and price of raw materials;
- R&D and innovation (new products/materials; automation and robotisation);
- IPR protection (EU and international; anti-counterfeiting)
- Environmental regulation (climate change; energy-intensity);
- Health, safety and security regulation (both workers and consumers).

Demand growth was not considered a *major* driver, even though demand can be expected to grow with further income and population growth (rated at 6).

For building materials, the main drivers include (rated at 8 and 9):

- Global competition;
- Trade liberalisation/WTO;
- Demand growth (driven by income and lifestyle changes, population growth);
- Availability and price of oil and energy;
- Availability and price of raw materials/substitution/recycling/re-use;
- Environmental regulation (climate change; energy-intensity);
- Health, safety and security regulation (both workers and consumers).

A marked difference between the two sub-sectors until recently has been the importance of international trade and global competition. While trade became increasingly important in glass and ceramics, and for high-value building materials (e.g. marble), heavier and low value building materials were subject to substantial international trade due to the high transport costs of materials in relation to value and volume of the latter. But over the last years, international trade has become more important in parts of the construction materials sector (e.g. in cement clinkers) due to further decreases in the cost of sea transport. As the drivers for the two sub-sectors are quite similar this study presents one set of scenarios covering the non-metallic materials sector. In the final workshop it was acknowledged that no major differences

Overview and description of exogenous drivers

- *Global competition*: Pressures for global competition ease in a protectionist environment vs. increasing levels of global competition in a climate of continuing globalisation. Obviously trade liberalisation issues (WTO Doha Round success yes/no?) matter for the scope and intensity of global of competition.

- *R&D and innovation*: R&D and innovation are important in creating *new products* and in opening up new markets; this is especially true in glass and ceramics (e.g. technical ceramics; glass fibres; functional ceramic particles), but also holds – though to a lesser extent - for certain parts of the construction materials industry (e.g. special applications of cement and concrete). R&D and innovation apply to *eco-innovation and sustainability* ('greening' of the economy), *both in new products/materials and in energy savings in production*, as well as to automation and robotisation (i.e. process innovations). The driver is ranked here as 'exogenous' as the scenarios are conceptualised at the EU sector level. At the micro-level of the individual firm R&D and innovation clearly are endogenous factors – more and smart investment in R&D and innovation can make a difference.
- *Demand growth*, especially for 'greener', i.e. more sustainable and less energy-intensive products, both in ceramics and glass (new materials) and construction materials (less energy-intensive and carbon-intensive products), the latter also experiencing a 'general' bigger demand (second homes, infrastructure renewal, more but smaller households and ditto housing; homes for the elderly).
- *Availability / price of oil and energy*: hydrocarbon prices reverting to long term average in a slowing and fragmenting world economy vs. scarcity driving prices of carbon in a further integrating, growing world economy. The non-metallic materials sectors all can be defined as energy-intensive.
- *Availability and price of raw materials*: the building materials and the glass and ceramics sub-sectors are heavy users of a wide range of raw materials. Rapidly increasing and structurally higher prices as a result of increasing scarcity and growing demand, also for substitutes, are contrasted with a situation in which relatively stable prices at more moderate levels prevail.
- *Income per capita*: slower growth of income per capita due to less global competition and a stalling global economy vs. faster growth of income per capita driven by an expanding global economy.

Overview and description of endogenous drivers

- *Environmental regulation*: environmental regulation being implemented according to current plans (most importantly: climate change plans and ETS going ahead, with further strengthening in the third trading period from 2013 onwards), reduction of energy use, classification of substances (REACH) at European level vs. environmental regulation comparable to current legislation, with some loosening up of the CO2 regime after revision of ETS in the third trading period in order to improve EU competitiveness, also as a 'protective' measure in view of the consequences the economic crisis.
- *Health, safety and security regulation*: health, safety and to a lesser extent security regulation plays an important role wherever hazardous substances and heavy materials (handling/loads) are involved; regulation applies to working conditions, but also to consumers (e.g. lead and other substances that can harm health, e.g. through food) and also includes security and safety rules and regulations in construction. (Strategic) security of supply of raw materials is another issue. With regard to health, safety and security further EU-wide harmonisation of existing health and safety regulation and measures to improve security of supply are assumed vs. a maintaining of current levels of regulation, no further harmonisation and a status quo in security of supplies.
- *Intellectual property rights protection/R&D and innovation policies:* with counterfeiting in glass and ceramics forming an increasing problem, active policies

including origin marking, improved enforcement of existing rules (border protection) and even a further strengthening of IPR rules and regulations in WTO and/or other global context are important to strengthen competitiveness and innovation. More active intervention and policing is hence assumed vs. a continuation of the status quo (resulting in even further increases in counterfeiting). This also holds for R&D and innovation policy *per se*: active and targeted R&D and innovation policies for the sector (e.g. focusing more on specific questions from and solutions for the industry) and a continuation of the present ('status quo').

- *Quality of institutions:* At the top of the scheme we assume a high quality institutional framework promoting the solution of problems, while at the bottom of the scheme the quality of institutions is low. Institutions are here defined narrowly as legal bodies supervising regulations.

10.3 The scenarios – detailed discussion

The scenarios are built based on two main groups of drivers. The first, positioned on the x-axis, relates to ongoing globalization, growing incomes, R&D and innovation and growing demand for non-metallic materials vs. a slowdown in globalization, trade and demand. On the vertical axis we find the drivers that can be influenced from a European (policy) perspective and associated to regulation (policies). The sector is highly energy-intensive (use of furnaces, high transport costs etc.) and a critical factor is whether environmental policies (especially in relation to climate change, and carbon dioxide emissions) will become significantly more stringent. This may be contrasted with a situation where Europe fails to agree on much stricter climate control measures and where present rules and regulations continue more or less as they are at present.

The exogenous drivers on the one hand comprise the picture of a world economy that is further integrating in a favourable climate towards globalisation and competition (right hand side) vs. a world economy that is increasingly showing protectionist attitudes caused by the economic crisis, a failure of the WTO Doha Round, global resource competition and labour relations (left hand side). The endogenous drivers on the one hand comprise the picture of a further integration of Europe that is actively pursuing higher standards in and harmonisation of environmental regulation implementing a stricter carbon dioxide emission policy, as well as enhanced health, safety and security regulations compared to emerging competitors, combined with improvements in IPR protection (ceramics and glass) (top) vs. a Europe that puts a halt to existing development, esp. in environmental legislation (esp. ETS in the third phase) and no further harmonisation in health, safety and security regulation. In the latter case emerging economies manage to catch up and improve their institutional settings and also in this respect close the competitive gap with Europe.

Based on the combination of endogenous and exogenous drivers the following four sector scenarios for non-metallic materials are distinguished:

- Scenario I: *Status quo*
- Scenario II: *Conservation*
- Scenario III: *Innovation-led growth*
- Scenario IV: *Resource depletion.*

Scenario I: *Status quo*
The combination of drivers for this scenario results in a world characterised by global protectionist tendencies leading to slow economic growth and easing competitive pressures, coupled with little progress in European harmonisation and setting of new environmental and security and safety regulations and standards shaping the sector. The European non-metallic materials sector benefits from relatively low global competitive pressures, but it also suffers from slowing demand for European products, lack of innovation and lack of new alternatives arising for raw materials and energy problems in the medium and longer term. Furthermore, in combination with the stagnating regulatory environment with little progress made in Europe, gradually new competitors arrive on the scene. This results in a declining of global position of the sector in the longer term, while global protectionist tendencies mean that the sector survives in Europe, but on a declining base.

Scenario II: *Conservation*
The combination of drivers in the Conservation scenario results in a world characterised by global protectionist tendencies leading to slow economic growth and easing external ('outside EU') competitive pressures, coupled with European harmonisation of and setting of new environmental, climate, and security and safety regulation shaping the sector. This means that Europe can sustain its advantage of high quality institutional environment compared to emerging competitors providing a competitive edge based on the conservation of resources at the European level.

The easing competitive pressures are expected to lead to reduced incentives for firms to seek new market segments or to invest in R&D and innovation, thus reducing the rate of restructuring. The drive towards conservation may be counteracted to some extent by lower economic growth in this scenario, reducing to some extent the incentives for resource conservation – unless counteracted by possible environmental regulation.

Scenario III: *Innovation-led growth*
The combination of drivers for the Innovation-led scenario results in a world characterised by further integration of markets leading to fast economic growth and continued global competitive pressures, coupled with European harmonisation of and setting of new environmental and security and safety regulation shaping the sector. This means that Europe manages to combine exploiting benefits of globalisation, sourcing raw materials and accessing production processes efficiently, while setting advanced environmental and safety standards that provide strong incentives to the industry to sustain its global innovative edge through the development of new products for a range of different markets (smart, lightweight, technical, nanotech-based, etc), the introduction of new technologies in production (including further automation and robotisation) and improvements in recycling. It should be mentioned that the Innovation-led growth scenario is seen as the most desirable scenario by the sector, as was concluded at the final workshop.

Scenario IV: *Resource depletion*
The combination of drivers for the Resource depletion scenario results in a world dominated by rapid economic growth and international competition as a result of increasing globalisation, coupled with a lack of new European (nor global!) regulations and standards on climate change and environment. This leads initially to rapid growth based on income growth in Europe and relatively low prices which do not incorporate environmental externalities. The growth pattern is quite resource intensive with cheapest materials sourced internationally, but also some high-value and rather scarce resources such as high quality magnesia (90% of

magnesia coming from China), bauxite (Guyana) and graphite. Eventually, prices will rapidly increase for those scarce materials resulting in reduced demand.

Note that the participants at the final workshop typified the resource depletion scenario as the most unlikely scenario. Yet for reasons of comparison – as a ‘gloomy’ future perspective - the scenario has been kept an integral part of the analysis.

11 Job functions – towards a workable structure

In order to determine the quantitative and qualitative implications of the scenarios for jobs and skills, a workable job classification is needed. The occupational classification of the available sector data derived from the Eurostat Labour Force Survey (LFS) is used as a starting point (see Box 3). The advantage of using this classification is that developments in the past as observed in the LFS can help to foresee likely trends for the future. For example, it might be expected that future developments in new Member States in some cases will follow similar paths as old Member States in the recent past. Moreover, where strong growth of certain job functions appeared in most recent years, one might have a reason to cautiously weigh and re-assess any further increases in future years, as the situation (markets and other factors) might have stabilised in the mean time. The share of job functions in total sector employment is not unimportant either; sizeable shares call for adequate attention. This does not imply that job functions with only very minor shares of the total should be ignored altogether. It might well be that occupations that have small shares now will face strong growth in the oncoming years, or are strategic and vital for growth of the sector as a whole, even if small in size.

However, the LFS job classification cannot be taken over one to one. First, the given LFS definitions of the job function groups are highly aggregated and cover therefore highly heterogeneous but not always comparable job functions. Reporting on this most aggregate level therefore would not be very illuminating. Second, some functions which may be strategic for the sector when looking at the future can be 'hidden' in a broader statistical category. This also includes 'new' emergent job functions. For both reasons some of the aggregated categories have been split up into separate job function categories, which have been given a more in-depth treatment. The opposite case, where certain job functions may be closely related, but do not fall within the same statistical LFS class, may also apply. Here it would be logical to combine them.

Box 3. The European Labour Force Survey

The European Union Labour Force Survey (LFS) is conducted in the 27 Member States of the European Union and 2 countries of the European Free Trade Association (EFTA) in accordance with Council Regulation (EEC) No. 577/98 of 9 March 1998. The data collection covers in total the years 1983 to 2006 and covers all industries and occupations. The national statistical institutes are responsible for selecting the sample, preparing the questionnaires, conducting the direct interviews among households. The Labour Force Surveys are centrally processed by Eurostat, using the same concepts and definition, based on the International Labour Organisations guidelines and common classifications: (NACE (rev 1), ISCO-88 (COM), ISCED, NUTS).

Although the LFS can be used for comparative purposes, the relative small sample size (in 2002 the sample size was about 1.5 million of individuals, which represents 0.3% of the EU population) means that error margins can be high, especially when the industry itself is rather small.

Source: Eurostat (2008)

Third, in the trend analysis it was already observed that whereas in some countries employment shares of a particular (production) job function were extremely large, similar shares in other countries appeared extremely low, often with another closely related job function being much higher. A very likely explanation for this phenomenon is that in some countries workers are reported as job function x while in others they are reported as job function y, where basically similar tasks on the job are performed. By taking aggregates for these function types, this sort of reporting bias can be avoided. Fourth, the job functions that

appear from statistical data analysis might not always be similar to what a person in or familiar with that sector would rank as the job functions that matter "in reality", i.e. from a work floor perspective. On the basis of discussions with experts and national sector skills studies, an attempt was made to provide a job classification that is both workable and recognisable by the sector in practice. This classification is shown as Table 11.1 below.

Table 11.1 Job classification

Classification in Labour Force Survey (LFS)	Detailed statistical classifications of jobs used in the LFS	Job function categories as used in the next tables*
Managers	Corporate and specialist managers covering all firm functions	Managers
Computing professionals	Computer systems designers, programmers and computer associate professionals	IT professionals
Engineers and related professionals	Production engineers and R&D personnel	Engineers and R&D
Business professionals	Accounting, finance and sales professionals	Accounting & Finance
		Sales & Marketing
Other professionals	Associated professionals; lawyers and economists	Other professionals
Office clerks and secretaries and service workers	Administration, order management, other support functions	Administrative support staff
		Truck drivers
Potters, glass making and other craft workers	Skilled workers for plant and machinery repair and maintenance	Plant and machinery repair and maintenance workers
Glass and ceramics plant operators	Production workers: skilled workers working in manufacturing operations in glass and ceramics products machine operators and assemblers	Skilled production workers
Metal mineral products machine operators		
Drivers / mobile plant operators		
Extraction and building trades workers	Low educated workers such as manufacturing labourers; also maintenance and cleaning personnel	Labourers
Labourers		

In order to establish a meaningful and appropriate classification, the existing LFS occupational classification for the non-metallic materials sector was adapted by either aggregating and/or selecting further differentiating some professions out of the original LFS statistical classification. This exercise was based on four criteria:

- employment shares (aggregating);
- closely related job functions (aggregating);
- strategic role in sector (disaggregating by further selecting among the occupational groups identified in the statistical classification);
- emergent job functions not yet covered and/or brought fully to light by current statistics.

Table 11.1 presents the detailed job functions for the non-metallic materials sector, based on the overall LFS classification and adapted to a workable structure. The following job functions are distinguished:

- *Managers*: top management and company owners/ entrepreneurs, but also different specialist managers, such as HRM, finance, production, sales, and R&D management.
- *IT professionals:* computing and information technology professionals such as system designers and programmes as well as lower computing professions and computer operators as well as industrial robot controllers.
- *Engineers and R&D*: chemical, mechanical, electronic and mining engineers, quality control engineers and engineers involved in R&D.
- *Accounting & Finance*: accountants and bookkeepers.
- *Sales & Marketing*: sales and marketing staff and product stewards.
- *Other professionals:* lawyers, economists, product design.
- *Administrative support staff*: office clerks / secretaries & support staff cover administrative functions, including order management and stock keeping.
- *Truck drivers:* Because of the bulk nature of much of the material process in this sector this an important category of support staff in this sector treated separately as this a sector using and producing bulky materials and products.
- *Plant and machinery repair and maintenance workers*: includes 1) machinery and precision workers such machinery mechanics and electrical and electronic equipment mechanics, 2) all craft related occupations not falling under metal, machinery and precision workers, including technician to repair plants and machinery.
- *Skilled production workers*: skilled production workers include mostly importantly plant and machine operators. Skilled production also includes quality control. The LFS category of "potters, glass makers and other craft workers" is very small in number and therefore included in this category.
- *Labourers*: generally low skilled employment such as manufacturing labourers, caretakers, porters and related workers.

12 Implications of scenarios by job function – volume effects

Different futures will have different implications for jobs, both in quantitative and in qualitative terms. In this chapter the implications of the four scenarios in terms of volume effects for each of the identified job functions are assessed. Trends and developments of the recent past provide an important starting point in forming an idea about these future developments. This quantitative trend information has been combined with expert opinions of a core expert team and supplemented with insights from invited sector experts in a dedicated workshop to assess which volume effects would be likely to occur for which job functions. It should be emphasized that the referred expected changes are qualitative in nature, reflecting the outcome of expert judgements and expert discussion as well as desk research taking into account the results of other studies. The results of the following chapter should therefore be used as a supplement and an independent expert assessment in addition to other more formal analyses, e.g. based on mathematical and/or econometric modelling and simulation.

With regard to shares of the different job functions in 2006 it can be observed that in the EU the most important functions are: extraction and building trades workers (222,000 persons), potters and glass makers (168,000), glass and ceramics plant operators (156,000), labourers

(151,000), drivers and mobile plant operators (138,000), office staff and secretaries (134,000), and managers (102,000).

The main volume changes observed in the 2000-2006 period are as follows:

- Strong growth is seen in the category extraction and building trades workers with and increase of 3% for the EU overall (2% in the EU15, and 5% in the NMS.)
- The strongest decline is observed in the category labourers, with an overall decline in the EU of 3% and growth rates of -1% and -13% in the EU15 and the NMS respectively.
- Drivers and mobile plant operators show a growth of 2% in the EU (!% in the EU15 and 4% in the NMS)
- Glass and ceramics plant operators have increased in numbers with 2% in the EU (1% in the EU15 and 4% in the NMS
- In the other professionals category an overall change of -1% is observed for the EU, with a 1% growth rate in the EU15 and a 13% decline in the NMS.
- Employment in the category potters and glassmakers is stable in the EU with a change of -2% in the EU15 and a 5% growth in the NMS.

These key observations in context of other trends and drivers in the industry were the basis for the assessment of relative volume effects of the different scenarios.

Table 12.1 Scenario implications: relative volume changes by job function and scenario 2009-2020

Scenario / Job function	Status quo	Conservation	Innovation-driven growth	Resource depletion
Managers	-	0	+	0
IT professionals	0	0	+	-
Engineers and R&D	-	+	++	-
Accounting & Finance	-	-	+	-
Sales & Marketing	0	0	+	0
Other professionals	0/+	+	+	0
Administrative support staff	-	-	0	-
Plant and machinery maintenance and repair	-	+	0	-
Truck drivers	0	-	+	-
Skilled production workers	0	+/-	+/-	-
Labourers	-	-	-	-
Overall job change	**-**	**+/-**	**+**	**-**

Source: TNO, based on expert consultation. Notes: - =decrease, +=increase, 0=maintain.

The results in table 12.1 represent the relative expected changes in the volume of workers by job function in the non-metallic materials sector. The tables show the different occupations

selected and the changes expected for each of the scenarios. In the last row an assessment of the overall expected job development is given.

Status Quo Scenario

The Status Quo scenario combines current levels of environmental regulation and moderate advances in global integration. There are no major innovative activities and overall the number of jobs is expected to decline. A different pattern can be observed within the EU with growth in the NMS and declines in the EU15. The non-metallic materials sector is a mature sector where there is an on-going process of rationalisation and growth in the scale of operation, leading to a decline in a number of job categories.

Since Europe (especially EU-15 countries) can only compete in the non-metallic materials sector with low-wage emerging economies through innovation and rationalisation, a lack of innovativeness would have negative consequences for the whole sector. An increase in rationalisation and scale of operations with relatively fewer staff will especially affect *low skilled labourers* with expected volume declines**.** The number of skilled workers is likely to remain stable in this scenario as no major new technologies and innovations are expected to be adopted in this mature sector. For the same reasons the *repair and maintenance staff* is also expected to experience a small decline. Due to the rationalisation of production and a increasing in scale of operations a downward trend is also foreseen for *managers*. In this regard *administrative support staff* is also likely to decline in this sector in the business as usual scenario. For *business and finance professionals* a modest decline is expected as a result of rationalisation. *ICT professionals* on the one hand experience a similar rationalisation as managers, but on the other hand the use of ICT is generally still increasing in all sectors including non-metallic materials. The resulting net trend is probably a stable number of jobs for ICT professionals in this scenario. The number of *sales professionals* is even more likely to be stable. Two counteracting trends may be expected here: a decline as a result of direct marketing (internet, which may have a positive effect on ICT professionals) and an increase in the luxury end of the market catering for affluent consumers. *Other professionals*, especially in the area of design may stabilise or may even experience some growth as companies increasingly aim to introduce high-quality products. The number of truck drivers will remain the same in this low growth scenario. Overall the ongoing rationalisation process will affect employment negatively. This may be (partially) compensated by the trend for unskilled jobs to be transformed into higher skilled types of employment. Unskilled labour is expected to decline especially fast in this scenario.

Conservation Scenario

The Conservation scenario differs from the Status Quo in the importance of regulatory changes. The sector underwent a major change in the last decade with the industry successfully focusing on the elimination of toxic materials and other emissions, a process that is now complete at least in the EU15. The key emerging challenge for this resource-intensive sector in this scenario is to deal with increasingly strict regulations on carbon dioxide emissions. This is reflected in an increase in the number of *other professionals* (lawyers, and design, see below). Other challenges include the use of raw materials and increasing prices of inputs, principally oil and gas. Some relocation of industries to avoid the growing burden of regulatory restrictions maybe foreseen, but in practice the scope for this is very limited due to the local nature of the industry and due to the bulky nature of raw materials and outputs. The highly local nature of the sector can also be seen from the large number of persons employed in the extracting and building trades sub-sector. As relocation is not a very feasible option,

industry will have no other choice than to comply with new regulatory regimes. Rather than just seeing this as a cost factor it may also be a strong stimulus to innovate.

The overall increase in scale in operations could in the Conservation scenario be combined with a shutdown of more polluting factories, as a result of which the demand for *low skilled labourers* is likely to decline. For the same reason the number of *accounting and financial employee***s** and *administrative support staff* might experience a slight decline. The number of *managers* is expected to remain about the same as a result of a combination of a declining trend due to ongoing increases in scale and the need to have additional managers who can deal effectively with a changing regulatory environment. The restructuring of operation and plant modernisation in the frame of environmental improvement in the Conservation scenario will increase the demand for *engineers* as well as for *plant, machinery maintenance and repair workers.*

There will be especially need for R&D, chemical, mechanical and environmental technology engineers to devise new environmentally friendly production processes. This will also increase the number of product designers (i.e. other professionals). This will open up new types of jobs. With regard to *skilled production workers* two distinct development paths are imaginable. On the one hand the restructuring and modernisation of the industry and the introduction of innovation may call for more specialised production workers. On the other hand, scale increases and the shutdown of more inefficient and pollutant plants together with rationalisation efforts may reduce the demand for skilled production workers. Due to a concentration on more successful plants and an overall political emphasis on environmental sustainability the demand for truck drivers is also likely to decline. The number of *ICT specialists* is expected to remain stable as in the previous scenario.

Innovation-led growth scenario

The "innovation-led growth" scenario depicts a world characterised by further integration of markets leading to fast economic growth and continued global competitive pressures, coupled with European harmonisation of and setting of new environmental (ETS 2^{nd} and 3^{rd} phase) and further harmonisation of health, safety and security regulation shaping the sector, with an important role for R&D and innovation. Europe manages to combine exploiting benefits of globalisation, sourcing raw materials and accessing production processes efficiently, while setting advanced environmental, health and safety standards that provide strong incentives to the industry to sustain its global innovative edge through the development of new products for a range of different market, the introduction of new technologies in production and improvements in recycling. The European trend to energy efficient housing calls for innovative building materials and even leads to the rediscovery of natural-based materials.

It is rather difficult for the EU (especially the EU-15) to compete with emerging countries like China and India or Eastern European countries in regard to labour costs. European countries can only stay competitive through an increase in automation and innovation. The innovation potential for standard products is limited and focuses more on improved production methods like better efficiency in energy and material usage. The main innovation potential lies in new and improved materials and products. EU-15 countries are therefore likely to concentrate more on product refinement, value added and high end / high tech products and emerge as an important innovator of improved sustainable technologies (automation, energy-efficiency, re-use and recycling) and as developer of new, high-tech and speciality products and materials, e.g. for the aerospace industry, challenging construction projects (road and rail fast and multi-layer infrastructure, mega high rise buildings, large bridges etc.), ICT, military technology

and medical engineering. Within Europe, the extraction and processing of raw materials might shift to Eastern Europe. Taken together, this will result in a decline for *low- and unskilled workers* especially for EU-15 countries. This will lead to a shift in workforce requirements and add new jobs to the sector.

High-educated and skilled workers such as *technical engineers and R&D personnel, environmental engineers and agronomists, designers* (in ceramics and glass) and *architects* (in construction materials) will gain in importance both in volume and in leading the sector. Interdisciplinary teams and ditto researchers will be favoured. Firms will face a highly competitive context in which product innovation (smart new materials, sustainable applications) goes alongside with process innovation (further automation, search for energy efficiency, recycling and re-use and sustainability in production).

The requirement for *skilled workers* however will not be affected by a decrease and European experts and skilled workers are likely to be needed abroad (e.g. in China, India and the Middle East) as consultants and trainers. This will be especially the case when emerging countries are also beginning to adopt stricter environmental legislation.

The demand for *ICT-related* jobs as well as *R&D personnel, engineers and environmental experts* will generally increase and a focus on high-end and speciality products will necessitate closer cooperation with the customers. However, ICT-jobs may also be offshored, leaving the net balance for Europe unchanged.

Due to globalisation the number of *administrative and accounting staff* based in Europe might decrease due to growing outsourcing and offshoring tendencies of back office activities. As products become more complex and high-end and new health and safety requirements will be implemented, an increase in staff familiar with legal issues may rise. The number of *plant and machinery maintenance and repair workers* is likely to increase due to higher degrees of automation. The same applies to *marketing personnel* as an increasing number of new products will be developed in this scenario which needs to be introduced, advertised and marketed.

Although continuing globalisation will lead to an growing demand for transport, the number of *truck drivers* may remain the same or even decrease as alternatives to road transport are encouraged. With a shift from standard and routine production to more high-value products and internationalisation, the number of *managers* is likely to increase. Managers of European origin may also be increasingly demanded by companies and partners outside the EU.

Resource depletion scenario

The combination of drivers for this scenario results in a world dominated by rapid economic growth and international competition as a result of increasing globalisation, coupled with a lack of new European regulations and standards on climate change and environment. This leads initially to rapid growth based on income growth in Europe and relatively low prices which do not incorporate environmental externalities. The growth pattern is quite resource intensive with cheapest materials sourced internationally, including scarce resources such as tropical hardwoods. Eventually, prices will rapidly increase for those scarce materials, especially energy, resulting in reduced demand.

Already during the growth phase, the EU is likely to belong to the losers because of high labour costs and high environmental standards compared to emerging and developing

countries. Environmental innovation which is a very important factor for Europe's competitiveness will lose its importance and the cheap production of standard goods will be in focus. After a relatively short period of very high growth, environmental problems and material scarcity will lead to a decline in growth and prosperity. Consequently this will lead to a decline in employees involved in the direct production process, i.e. *unskilled* and *skilled labourers, plant and machinery maintenance and repair workers* as well as personnel related to transportation like *truck drivers***.** This also negatively affects employment in *administrative support staff, accounting and finance, sales and marketing and even management.* Recycling technologies may emerge as a new business field, thus transforming part of the non-metallic sector.

Engineers and *R&D personnel* might be the least affected group and demand may even rise in face of finding new ways to cope with the deteriorating situation. The first one with an innovative idea will have a global market advantage. The development of the demand for ICT professionals may depend on the nature of their activity. In regard to sales and administrative activity a decline is likely, whereas the demand for ICT-workers in relation to R&D and engineering may stay the same or even increase.

13 Implications of scenarios - main emergent competences

13.1 Introduction

Determining emergent competences is at the very heart of this study. In order to identify the main emergent competences by occupational function, the Rodrigues (2007) methodology refers to three main competences: theoretical, technical and social competences. This distinction builds on the distinction between knowledge, skills and competences in the European Qualifications Framework (EQF) and the European Credit system for Vocational Education and Training (ECVET) (see Box 4 below). The term human capital broadly defined by the OECD as 'the knowledge, skills, competencies and attributes embodied in individuals that facilitate the creation of personal, social and economic well-being' (OECD, 2001:18) captures all three. The use of the term 'capital' leads one to think in terms of investments in education and training which are often necessary in order to acquire skills and knowledge. However, skills and knowledge can also be acquired through work experience, informal on-the-job learning and a variety of other means.

In the actual identification of future competences, the EQF/ECVET definitions are used as indicative. It is noted that the difference between competences and skills is not always clear-cut, for instance where 'soft skills' come into play. A similar comment holds for what determines job or occupational qualifications.[16] Partly because of these identification issues, adequate measurement of competences, knowledge and skills is notoriously difficult. In some

[16] 'Qualification' denotes the requirements for an individual to enter or progress within an occupation. It also denotes an official record (certificate, diploma) of achievement which recognises successful completion of education or training, or satisfactory performance in a test or examination. The concept of qualification varies from one country to another. It may express the ability – formally defined in work contracts or collective agreements – to perform a certain job or meet the requirements of the workplace. A qualification may give rise to a number of rights and prerogatives which determine the individual's position within the hierarchy of his/her occupational context. (Tessaring, 2004: 235).

of the literature, the problem of skills measurement is sometimes avoided by using indicators (proxies) focusing on qualifications (high-level, intermediate-level, low-level) as well as occupations. For the purpose of identifying *future* skill needs such approach will not deliver useful results. Instead it is the knowledge and skills behind that need to be identified.

Rather than producing a full and exhaustive list of all competences for each job function, the key focus in this chapter is on identifying and describing key and critical competences for the future. The description will be focused but also general enough to be meaningful across countries. A slight extension of the original Rodrigues methodology is that together with the identification of critical skills and knowledge needs, a differentiation by scenario is made. Skills and knowledge needs are operationalised as expected key changes in specific skills and knowledge categories by occupation.

Box 4. Definition of competences, skills and knowledge in EQF and ECVET

Several definitions of knowledge, competences and skills are nationally as well as internationally under discussion. Moreover, Member States of the European Union still have different approaches in defining these terms. The European Union has set up a joint process to co-ordinate the different existing terminologies and to find a common basis. Aims of this process are for example to strengthen the mobility of the labour force within the European Union and to facilitate sectoral developments. In the following reference is made to the definition used by the European Qualification Framework (EQF) and the European Credit System on Vocational Education and Training (ECVET).
The EQF links national qualification systems and tries to make vocational training and lifelong learning more transparent and understandable. Therefore a common terminology was developed. The following descriptors are taken from the EQF (European Commission, 2008e; see also European Commission, 2008f):

- *Knowledge* refers to the outcome of the accumulation of information through learning. Knowledge is the body of facts, principles, theories and practices that is related to a field of work or study. In the context of the European Qualifications Framework, knowledge is described as theoretical and/or factual;

- *Skills* refers to the ability to apply knowledge and use know-how to complete tasks and solve problems. In the context of the European Qualifications Framework, skills are described as cognitive (involving the use of logical, intuitive and creative thinking) or practical (involving manual dexterity and the use of methods, materials, tools and instruments);

- *Competence* refers to the proven ability to use knowledge, skills and personal, social and/ or methodological abilities, in work or study situations and in professional and personal development. In the context of the European Qualifications Framework, competence is described in terms of responsibility and autonomy;

- *Qualification* refers to a formal outcome of an assessment and validation process which is obtained hen a competent body determines that an individual has achieved learning outcomes to given standards;

- *Learning outcomes* refer to statements of what a learner knws, understands and is able to do on

Throughout this report the term competences is defined as the "proven ability to use knowledge, skills and personal, social and/or methodological abilities, in work or study situations and in professional and personal development." (see Box 4 for definitions). In the practical elaboration of competence needs hereafter the focus is predominantly on knowledge and skills needs, with a further distinction to what is usually described as 'hard skills' (knowledge) and 'soft skills' such as team working skills, and planning and organising. Note that the 'personal, social and/or methodological abilities' included in the definition of competences (see Box 5) come very close to what is generally understood as 'soft skills'.

Box 5. Skills needs, skills shortages and skills gaps defined

- *Emergent skills needs* are defined here as the change in skills that is needed to adequately fulfil a certain job function in the future. Addressing emergent skills is needed in order to avoid skills shortages and/or skills gaps in the future.
- *Skills shortages* exist where there is a genuine lack of adequately skilled individuals available in the accessible labour market. A skill shortage arises when an employer has a vacancy that is hard-to-fill because applicants lack the necessary skills, qualifications or experience.
- *Skills gaps* arise where an employee does not fully meet the skills requirements for a specific job function but is nevertheless hired. This skills gap needs to be closed through training. Skills gaps can arise where new entrants to the labour market are hired and although apparently trained and qualified for occupations still lack some of the skills required.

A number of different skills categories have been taken into account, including social skills, problem solving skills, (self) management skills, skills related to entrepreneurship, as well as knowledge requirements (sometimes labelled as 'hard skills'). Table 13.1 provides an overview of the different skills and knowledge categories taken into consideration. Literacy and numeracy skills are not specifically mentioned in the tables. In practice these skills cannot be taken for granted. However, they are a prerequisite rather than an emerging skill to participate in the workforce especially in highly regulated and science-based sectors such as chemicals

Table 13.1 Overview of skills and knowledge clustered by category

Knowledge ('hard skills')
• Legislative / regulatory knowledge (environmental / safety / labour / contracting); Language*; e-skills (i.e. ICT-related skills); Marketing skills; Technical knowledge; Product knowledge; Product development
Social Skills • Team working skills; Social perceptiveness (listening / understanding); Communication; Networking; Language*; Intercultural
Problem-solving Skills • Analytical skills; Interdisciplinary; Initiative, Multi-skilling; Creativity
Self management • Planning; Stress and time management; Flexibility; Multi-tasking
Management skills • Strategic & visionary; Coaching and team building; Change management; Project management; Process optimizing; Quality management; people skills crucial for collegial management style
Entrepreneurial skills • Supplier and customer relationship / understanding; Business understanding; Trend setting / trend spotting

.

For each job function key future skills and knowledge needs were identified. This was done in a workshop with a number of invited sector experts, and validated in two subsequent workshops, including the step 10 final workshop; the results therefore remain based on joint expert opinion. The analysis in Part I and the data tables formed a 'levelling' starting point for each of the discussants.[17]

Within the four scenarios, "status-quo", "conservation", "innovation-led growth" and "depletion" presented above, the "innovation-led growth" scenario is the most challenging in the context of new skills. It deals with changes on more than one dimension, including rising emphasis on environmental aspects, the need for faster innovation to stay competitive and the operation within a global framework. The "conservation" scenario also builds on great emphasis on environmental improvements in this currently comparatively energy-intensive sector, but focuses less on product innovation and is limited to the European territorial framework. The "status-quo" scenario on the other hand will be the most unchallenging since it implies a continuation of the "status quo". The "depletion" scenario will be more a scenario of survival with a general degeneration on industrial capacities. Therefore the "Innovation-led" scenario will stand in focus of our analysis.

The importance of the "innovation-led" scenario in view to changes in skills can be characterised as follows:

- Globalisation and growing competition from emerging countries
- Eco-innovations: rising efficiency of the sector but also a demand for eco-efficient materials from the sector (e.g. energy-efficient building materials, insulating materials, materials for house-refurbishment in regard to energy consumption)
- Insulation materials may become an important product segment for EU-15 countries in this sector
- Non-metallic materials will play a key role for achieving more environmental efficiency and for developing new products (e.g. in aeronautics or medicine)
- The scenario is highly dependent on the economic situation (in regard to building activities and special purpose materials)
- Materials and special materials will become increasingly important in the future
- A blurring of borders between non-metallic sector, metallics and plastics can occur
- Increasing interdisciplinary requirements and new fields entering the sector (e.g. nanotechnology, biotechnology, bionics/biomimicry, functional materials, smart materials etc.
- General up shift of the sector from low-medium technology to a more high-tech orientation may be expected
- Materials as such will play an increasingly important role in the future and will be a driver and enabler for general innovation
- Globally the centre of building activities will shift to China, India and the Middle East
- Global co-operation will increase
- Large companies will dominate (in the "conservation" scenario, SMEs will be more common than in the "Innovation-led" scenario, since there is less global competition and they will get better protected and supported.)

[17] The emerging skills and knowledge needs of the following job functions were validated and complemented where necessary at the final workshop: engineers & R&D personnel, sales & marketing, skilled production workers, plant and machinery repair workers.

The emergent future competences – defined as skills and knowledge needs - are identified and clustered together with similar ones in a concise overview table per job function (see next sections 13.2 to 13.12). Only ***substantive key changes*** in skills and knowledge needs are taken into account, which means that only part of the cells in the table is 'filled'. However, if a certain skill or knowledge type is highlighted in one scenario, but is not addressed in another, this does not mean that it is irrelevant. Rather it means that relative demand for this skill in the latter case will not increase within the time frame 2009-2020. It is *assumed* that the "status quo" scenario does not imply *substantive* change in any of the skills or knowledge categories, even though some change no doubt will have to be made. Therefore the tables in the next sections will only focus on the "conservation", "innovation-led growth" and "depletion" scenarios.

13.2 Managers

New skills and competences for managers are presented in table 13.2. In the “innovation-led” scenario the success of the EU-15 countries lies in their ability to develop new products, materials and processes. The degree of globalisation is high, while on the other hand environmental regulations are quite strict. In this context it is imaginable that European producers also open up production facilities abroad (e.g. in China, Brazil, India) or establish international co-operations. In this scenario, material sciences and development will generally be very important for many other industries like energy production and distribution, environmental technology, ICT, medical engineering and transport. The expectations and standards for construction materials (e.g. cement, glass and insulation materials) will become higher in the context of ecological considerations, especially in EU-countries. Scientific development as well as international market complexity will grow, necessitating a broad range of skills from managers and the capability for fast strategic decision making.

- The “innovation-led” scenario is the most challenging with regard to social skills. Growing international co-operation and dealing with new markets (for Europe especially the booming regions in the Middle East) and industries and probably an increasingly foreign workforce, requires strong intercultural skills. Besides language skills where non-western languages like Chinese, Hindi and Arabic may grow in importance, the ability to deal with non-European cultures in business and contracting will require new managerial abilities. The conservation scenario is more focused on the aspect of environmental considerations and is less internationally oriented.
- Since in the “innovation-led” scenario innovativeness in the main driver for success, the necessity for interdisciplinary co-operation will rise. Although managers are generally less involved directly in R&D activities, they have to know more about other areas and industries that could provide useful input for product innovations. The ability to take initiatives and multi-skilling will be necessary to keep ahead of competitors. The “conservation” scenario has less emphasis on entrepreneurial undertakings and is more bound to prescribed regulations. This requires less initiative-taking and creativity. The “status-quo” does not require problem-solving skills that go beyond current trajectories.
- Also entrepreneurship is very important in the “innovation-led” scenario where the emphasis is especially high on forecasting and trend-setting / trend-spotting but also anticipating (global) market and business development and a better understanding about customers and suppliers is important. Companies have to constantly keep ahead of competitors with increasingly sophisticated products. In the “conservation” scenario, anticipating the future is of less relevance, but an understanding of suppliers and customers is likely to become more important. Flexibility is important in the “innovation-led” scenario and in the “depletion” scenario, although from different perspectives (coping with more challenging products and customers vs. arranging with scarcity).
- In the “innovation-led” scenario, change management will be of great importance, which also applies to a slightly lesser degree to the “conservation scenario”. Strategic and visionary competences are also important in the “innovation-led” scenario. The “depletion” scenario might put more emphasis on crisis management.
- Managers in general need not to be experts in technical or legal issues, but the “innovation-led” scenario and especially in the “conservation” scenario, a general knowledge about regulations and legal issues (e.g. environmental laws, standards, norms etc.) will be necessary.

Table 13.2 Emerging skills and competences: Managers (2009-2020)

		Innovation-led scenario	Conservation scenario	Depletion scenario
Social Skills	Team working skills			
	Social perceptiveness			
	Communication			
	Networking			
	Language			
	Intercultural			
Problem solving skills	Analytical skills			
	Interdisciplinary			
	Initiative			
	Multi-skilling			
	Creativity			
Self management	Planning			
	Stress & time management			
	Flexibility			
	Multi-tasking			
Entrepreneurship	Understanding supplier & customers			
	Business development			
	Marketing skills			
	Trend setting / spotting			
Management skills	Strategic & visionary			
	Coaching & team building			
	Collegial management style			
	Change management			
	Project management			
	Process optimizing			
	Quality management			
Knowledge	Legislative & regulatory knowledge			
	e-skills			
	Technical knowledge			
Total emerging skills and competences		Count: 17	Count: 6	Count: 4

13.3 IT professionals

In general, social and entrepreneurial skills are less important for IT professionals than for other employment categories, but nonetheless they will become more required especially in the “innovation-led” and “conservation” scenario. New skills and competences for IT staff are presented in table 13.3.

- Even in the “status quo” and “depletion” scenario, the factor ICT will remain important, but no fundamentally new competencies are required for the non-metallic materials sector.
- Especially in the “innovation-led” scenario and to a lesser extent in the “conservation” scenario ICT activities themselves are likely to become relevant as tools for product development and testing. Especially virtual product design, simulations and non-destructive material testing can provide substantial advantages over competitors. Whereas simple ICT activities like customer services, sales, server administration and ICT communication may be outsourced/offshored to countries like India, R&D-related ICT skills which are currently more encountered in high-tech industries like aerospace, pharmaceuticals or biotechnology (e.g. complex modelling, simulations, statistical analysis), will be increasingly in demand also in the non-metallic materials sector.
- The “innovation-led” scenario is based on the assumption of general growth and technological progress. Therefore it is likely that computer technology will also develop in a rather fast pace, requiring constant observation and adaptation to the state-of-the art of useful possibilities to stay innovative and competitive. Trend setting and spotting will be important to keep up with changes.
- The “innovation-led” scenario will very likely have more international ICT workers co-operating with each other. Country-specific differences in education, training, procedures and approaches may pose new challenges for team-working and intercultural skills. Therefore team-working skills, coaching, communication, networking, language and intercultural competencies will become more important except for the “depletion” scenario. Already today, ICT-workers state that the cultural and education-based differences in approaches between European and Indian programmers can be challenging.
- Project management and process optimisation will become more important in all scenarios with quality management also adding up in the “innovation-led” and “conservation” scenario.
- Since the legal framework in ICT is also further developing, specific legal and regulatory knowledge could also become more important, whereas the change may not as great as with other skills.

Table 13.3 Emerging skills and competences: IT Professionals (2009-2020)

		Innovation-led scenario	Conservation scenario	Depletion Scenario
Social Skills	Team working skills			
	Social perceptiveness			
	Communication			
	Networking			
	Language			
	Intercultural			
Problem solving skills	Analytical skills			
	Interdisciplinary			
	Initiative			
	Multi-skilling			
	Creativity			
Self management	Planning			
	Stress & time management			
	Flexibility			
	Multi-tasking			
Entrepreneurship	Understanding supplier & customers			
	Business development			
	Marketing skills			
	Trend setting / spotting			
Management skills	Strategic & visionary			
	Coaching & team building			
	Collegial management style			
	Change management			
	Project management			
	Process optimizing			
	Quality management			
Knowledge	Legislative & regulatory knowledge			
	e-skills			
	Technical knowledge			
Total emerging skills and competences		Count: 15	Count: 13	Count:5

13.4 Other professionals

Other professionals are defined as highly qualified workers like economists or law professionals. New job occupations in the sector like environmental specialists and agronomists to work on socio-economic and organizational issues of working towards a more sustainable and 'green' image are caught under this job function. Those environmental specialists and agronomists working on technical solutions are ranked under the category of engineers and R&D. Most change is expected in the "innovation-led" and "conservation" scenarios, and only very little change in the "depletion scenario". New skills and competences for this group are presented in table 13.4.

- Since regulations will become more complex the "innovation-led" and "conservation" scenario, a growth in analytical skills in broader contexts is needed.
- Especially in the "innovation-led" scenario, internationally oriented economists and law professionals will be required. Also adaptability to changes (i.e. flexibility) will be of advantage.
- Specialisations like on Chinese or Indian economy, environmental economy and legislation, patent law, copyright protection, norms and standards and reliability/claim management will emerge as increasingly important areas for professionals, especially in the "innovation-led" scenario.
- Besides specialisation, especially the "innovation-led" scenario calls for operating within bigger pictures, requiring more interdisciplinary competencies.
- In the "conservation" scenario, the emphasis lies on environmental and energy aspects and EU-regulations.

Table 13.4 Emerging skills and competences: Other Professionals (2009-2020)

		Innovation-led scenario	Conservation scenario	Depletion Scenario
Social Skills	Team working skills			
	Social perceptiveness			
	Communication			
	Networking			
	Language			
	Intercultural			
Problem solving skills	Analytical skills			
	Interdisciplinary			
	Initiative			
	Multi-skilling			
	Creativity			
Self management	Planning			
	Stress & time management			
	Flexibility			
	Multi-tasking			
Entrepreneurship	Understanding supplier & customers			
	Business development			
	Marketing skills			
	Trend setting / spotting			
Management skills	Strategic & visionary			
	Coaching & team building			
	Collegial management style			
	Change management			
	Project management			
	Process optimizing			
	Quality management			
Knowledge	Legislative & regulatory knowledge			
	e-skills			
	Technical knowledge			
Total emerging skills and competences		Count: 13	Count: 9	Count: 1

13.5 Engineers and R&D personnel

Currently the non-metallic (mineral) production industry is categorised as a medium-low-technology industry (Hirsch-Kreinsen, 2006). Engineers and R&D personnel are crucial in the more innovation-prone sub-sectors. It includes new job functions like *environmental specialists* and *agronomists* working on technical solutions regarding energy efficiency and on developing sustainable products are ranked under the category of "engineers and R&D". It also includes the upcoming job category of *designers* (in ceramics and glass) and *architects* (in construction materials). New skills and competences for engineers are presented in table 13.5.

In the "status-quo" and "depletion" scenario, engineers and R&D personnel will generally only play a minor role. Therefore these scenarios will not be emphasised here. The only remark is that in the "depletion" scenario, the necessary skills of engineers might shift away from product improvement as such to finding ways of dealing with scarcity. The "innovation-led" scenario will require changing skills for engineers and R&D personnel, especially in the domains of knowledge and problem-solving, but also more soft skills. In the "conservation" and "innovation-led" scenario, the general quality and innovation requirements for materials will increase. The demand will shift away from standard materials being used today to special purpose materials with better environmental characteristics, improved insulation properties, improved safety, adaptability (e.g. in regard to environmental influences) and properties like bullet proof, easy to recycle, self cleaning and biocompatibility (e.g. for medical products).

In general, these two scenarios also derive from the assumption that R&D activities and engineering will operate in close proximity. Since the "innovation-led" scenario drives every industry to stay ahead of the competitors, leading to a general acceleration in innovation efforts, the classic boundaries between disciplines as well as between basic research and applied science may begin to blur.

- Increasing interdisciplinary co-operation will be an outstanding characterisation of the "innovation-led" scenario. Materials will be an essential part and key technology for overall innovations. New developments might even blur the classic borders between metallic materials, non-metallic materials, organic materials and plastics. Fields like nanotechnology, biotechnology and biomimetics will become new umbrella disciplines that are also going to be relevant for the non-metallic industry sector. Since the engineers have to optimise on the two dimensions of ecological improvement and new product development, an increasing number of factors have to be taken into account in the engineering process. Engineering is likely to become more customised, finding the best solution for special purposes and climate conditions. This requires new hard skills for engineers working in this sector, cutting through different and new disciplines. It is imaginable that even totally new products, processes and procedures will be developed by 2020.
- The state-of-the-art of knowledge is likely develop and change more rapidly, necessitating engineers to constantly actualise their knowledge and skills. The formal training or university education is therefore likely not to suffice for very long.
- Computer-based product design and optimisation of production methods are also likely to become more important in the "innovation-led" scenario. Engineers are required to work increasingly with simulation techniques, modelling, programming

Table 13.5 Emerging skills and competences: Engineers and R&D personnel (2009-2020)

		Innovation-led scenario	Conservation scenario	Depletion Scenario
Social Skills	Team working skills			
	Social perceptiveness			
	Communication			
	Networking			
	Language			
	Intercultural			
Problem solving skills	Analytical skills			
	Inter-/multidisciplinary			
	Initiative			
	Multi-skilling			
	Creativity			
Self management	Planning			
	Stress & time management			
	Flexibility			
	Multi-tasking			
Entrepreneurship	Understanding supplier & customers			
	Business development			
	Marketing skills			
	Trend setting / spotting			
Management skills	Strategic & visionary			
	Coaching & team building			
	Collegial management style			
	Change management			
	Project management			
	Process optimizing			
	Quality management			
Knowledge	Legislative & regulatory knowledge (e.g. IPR)			
	e-skills			
	Technical knowledge: - Materials science - Process and mining - Environmental management			
Total emerging skills and competences		Count: 24	Count: 13	Count: 3

and in-silico-testing, especially in regard to the material reaction with the environment. The requirements as well as the technology will become more sophisticated in the "innovation-led" and "conservation" scenario.

- In the "conservation" and "innovation-led" scenario, environmental technologies and sciences will comprise an important emergent skill category for engineers.
- Specialisation as well as interdisciplinary capabilities is especially important in the "innovation-led" scenario, which may require a new type of knowledge that can be

named “speci-generalisation”, meaning the ability to know how to best apply highly specialised knowledge in a highly interdisciplinary, complex and global context. This necessitates the ability to position ones contribution of special knowledge in a large context. Creativity and flexibility will also become more important.

- In the “conservation scenario” and the “innovation-led” scenario, engineers will be required to possess more knowledge about legal aspects and regulation affairs. In the “conservation scenario” this especially affects the environmental dimension, while in the “innovation-led” scenario the importance of international norms, regulations and standardisation as well as industry specific regulations will be of greater importance.
- Since the current form of production is likely to change in the “innovation-led” and “conservation” scenario, those scenarios will especially affect production engineers that will be faced with new materials, new production methods, new regulations and new machines.
- Especially in the innovation-led scenario, social, managerial and entrepreneurial skills like trend-spotting / trend setting and a better understanding of customers and suppliers, team building, coaching and project management will become increasingly important for engineers.
- Due to growing internationalisation (“innovation-led” scenario) and a possibly higher rate of women working in this rather male dominated field, intercultural skills as well as “gender competency” will be required.
- In the “innovation-led” scenario, engineers will increasingly required to work abroad (e.g. in China, Brazil, India, Middle East, South Africa) to train the personnel of regional co-operation partners. Thus engineers will be required to possess language, intercultural and educational skills.

13.6 Accounting & Finance

Accounting and finance professionals are and will also in the future be needed for controlling, bookkeeping and financial activities of firms. In general they require high analytical skills as well as a developed set of soft skills. Again, the situation will be especially challenging for the "innovation-led" scenario, where the premises will derive from increasing globalisation, including mergers and acquisitions. Simple accounting tasks may be outsourced / offshored further to countries with lower labour costs (e.g. India, South Africa), as is already happening now. New skills and competences for this group are presented in table 13.6.

- Least demanding will be the "depletion" scenario; apart from a stronger need for e-skills, flexibility and process optimizing skills not much additional skills needs will emerge.
- Team working, communication, networking, language and intercultural competencies will become even more important in the "innovation-led" and "conservation" scenario.
- Since operations are likely to take part within different time-zones, non-classic working hours may enter the accounting domain, calling for flexibility, new ways of planning and stress-management.
- Increased project work and short term co-operations might make accounting generally more challenging due to an increasing number of changing partners and clients. The understanding of customers and suppliers will become generally more important. The same applies for management skills like process optimisation and quality management.
- Computer-based assistance will be increasingly required in accounting, calling for new ICT-skills and dealing with constantly improving or changing software solutions and e-security requirements. This may require re-training on a routine basis.
- Internationalisation requires competencies to operate within international economies, necessitating international knowledge about global economic, financial and monetary settings and regulations as well as language skills and cultural knowledge.

Table 13.6 Emerging skills and competences: Accounting & Finance (2009-2020)

		Innovation-led scenario	Conservation scenario	Depletion scenario
Social Skills	Team working skills			
	Social perceptiveness			
	Communication			
	Networking			
	Language			
	Intercultural			
Problem solving skills	Analytical skills			
	Interdisciplinary			
	Initiative			
	Multi-skilling			
	Creativity			
Self management	Planning			
	Stress & time management			
	Flexibility			
	Multi-tasking			
Entrepreneurship	Understanding supplier & customers			
	Business development			
	Marketing skills			
	Trend setting / spotting			
Management skills	Strategic & visionary			
	Coaching & team building			
	Collegial management style			
	Change management			
	Project management			
	Process optimizing			
	Quality management			
Knowledge	Legislative & regulatory knowledge			
	e-skills			
	Technical knowledge			
Total emerging skills and competences		Count: 11	Count: 10	Count: 3

13.7 Sales & Marketing

Sales & marketing staff (table 13.7) is responsible for managing customer relations, marketing the products and managing sales activities. In the “status quo” and “depletion” scenario, the requirements for sales and marketing staff are not expected to undergo noteworthy qualitative changes, except for self management, business development, marketing and ICT, which are generally the core areas of this employment section. Especially in the “innovation-led” scenario and to a lesser extent in the “conservation” scenario, a greater emphasis on social and entrepreneurial skills is to be expected.

- The expansion and exploration of new markets, especially in the “innovation-led” scenario will require customised marketing skills tailored to specific cultural, clients and industrial settings. A one-size-fits-all marketing strategy will not be appropriate anymore. Thus flexibility and the understanding of (individual) customers will be a great skill advantage. Other entrepreneurial skills like business development, marketing skills and even trend spotting in the “innovation-led” scenario will become very important.
- Since in the” innovation-led” scenario, a considerable proportion of the product palette will exist of new products or speciality products with higher complexity and more features, sales & marketing personnel will be required also to possess a more extensive knowledge about the products and the technical/engineering factors.
- Knowledge about regulations and legal aspects will be important in the “conservation” and “innovation-led” scenario, where sales and marketing personnel should be able to emphasise aspects in regard to environmental and safety regulations besides promoting other innovative features.
- e-skills will remain important and also change in quality over time. New computer technology, new marketing concepts and an increase in business virtualisation will require sales and marketing workers to constantly update their technology, procedures and skills.
- Consultant work will be increasingly required in the “conservation” and “innovation-led” scenarios, e.g. energy and renovation consultancy. This requires knowledge in regulations, products and customer-relations skills.

Table 13.7 Emerging skills and competences: Sales & Marketing (2009-2020)

		Innovation-led scenario	Conservation scenario	Depletion scenario
Social Skills	Team working skills			
	Social perceptiveness	Only in SMEs		
	Communication			
	Networking			
	Language			
	Intercultural			
Problem solving skills	Analytical skills			
	Interdisciplinary			
	Initiative	As peacekeepers		
	Multi-skilling			
	Creativity			
Self management	Planning			
	Stress & time management			
	Flexibility			
	Multi-tasking			
Entrepreneurship	Understanding supplier & customers			
	Business development			
	Marketing skills			
	Trend setting / spotting			
Management skills	Strategic & visionary			
	Coaching & team building			
	Collegial management style			
	Change management			
	Project management			
	Process optimizing			
	Quality management			
Knowledge	Legislative & regulatory knowledge			
	e-skills			
	Technical knowledge, i.e. product knowledge			
Total emerging skills and competences		Count: 21	Count: 12	Count: 5

13.8 Administrative support staff

Administrative support staff (table 13.8) should be understood here as being in support of all other job functions and to improve work effectiveness. The category of support staff is defined here to include all other support job functions than the ones that have already been described and not requiring tertiary education. Most support staff functions are administrative related jobs. Key knowledge required for these activities are up-to-date e-skills to function effectively in an administrative environment (basic internet skills; spreadsheet and word processing skills; e-monitoring skills). This holds for all scenarios. The same holds for planning, stress management and flexibility skills. Especially in the “innovation-led” and the “conservation” scenario, the requirements for support staff will also grow in tune with rising demands for the more senior levels and will be quite similar. In the “conservation” scenario which is more EU-focused than international, language and intercultural skills may be of less importance. For both the “innovation-led” and the “conservation” scenarios the following applies that:

- If the overall pace of development will increase as is the case in the “innovation-led” scenario due to overall innovation pressure, support staff will also need skills in the area of multi-tasking, planning, flexibility and a better understanding of customers and suppliers, thus requiring better stress management.
- Besides team working and communications skills, even lower skilled support staff might need language and intercultural competencies.
- Support staff working in R&D or engineering will need more and different hard knowledge, solid training and constant re-training and may be confronted with new technology areas, procedures and machinery.

Table 13.8 Emerging skills and competences: Administrative support staff (2009-2020)

		Innovation-led scenario	Conservation scenario	Depletion scenario
Social Skills	Team working skills			
	Social perceptiveness			
	Communication			
	Networking			
	Language			
	Intercultural			
Problem solving skills	Analytical skills			
	Interdisciplinary			
	Initiative			
	Multi-skilling			
	Creativity			
Self management	Planning			
	Stress & time management			
	Flexibility			
	Multi-tasking			
Entrepreneurship	Understanding supplier & customers			
	Business development			
	Marketing skills			
	Trend setting / spotting			
Management skills	Strategic & visionary			
	Coaching & team building			
	Collegial management style			
	Change management			
	Project management			
	Process optimizing			
	Quality management			
Knowledge	Legislative & regulatory knowledge			
	e-skills			
	Technical knowledge			
Total emerging skills and competences		Count: 11	Count: 9	Count: 3

13.9 Truck drivers

Truck-drivers (table 13.9) are currently an important category of support staff since many of the products consist of bulky components. The “innovation-led” and “conservation” scenarios will not differ for truck drivers. Since environmental and energy-related dimensions are important to both scenarios, fuel-saving driving skills may become very important. Also the technologies within trucks are likely to increase (navigation, safety technologies, driver assistance etc.) as well as regulations for traffic and transport, necessitating skills-updates for drivers.

Communication skills as well as language and intercultural competencies may also become more important for truck drivers as well as flexibility and stress management, one factor that is already very important for this job today. This holds for all scenarios, also for the “depletion” scenario, except for stronger demands on social skills and self management in the ‘race’ for depletion driven by strong competition.

Table 13.9 Emerging skills and competences: Truck drivers (2009-2020)

		Innovation-led scenario	Conservation scenario	Depletion scenario
Social Skills	Team working skills			
	Social perceptiveness			
	Communication			
	Networking			
	Language			
	Intercultural			
Problem solving skills	Analytical skills			
	Interdisciplinary			
	Initiative			
	Multi-skilling			
	Creativity			
Self management	Planning			
	Stress & time management			
	Flexibility			
	Multi-tasking			
Entrepreneurship	Understanding supplier & customers			
	Business development			
	Marketing skills			
	Trend setting / spotting			
Management skills	Strategic & visionary			
	Coaching & team building			
	Collegial management style			
	Change management			
	Project management			
	Process optimizing			
	Quality management			
Knowledge	Legislative & regulatory knowledge			
	e-skills			
	Technical knowledge			
Total emerging skills and competences		Count: 9	Count: 9	Count: 5

13.10 Skilled production workers

Production workers are involved in the manufacturing of non-metallic products like concrete/cement, glass, non-metallic building materials, ceramics, non-metallic composites etc. In the “status quo” and “depletion” scenarios, the kind of production and products will not change in a noteworthy way. Because of the pace and competition involved in the “depletion” scenario, with less workers available, the stress management, self discipline and flexibility needs will be stronger. Greatest changes are expected in the “innovation-led” scenario and to a lesser degree in the “conservation” scenario. In contrast to other job functions, soft skills and managerial competencies are generally much less relevant for production workers. This category of workers includes the ‘automators’ and those specialised in operating robotics, requiring responsibilities of supervising, controlling and checking automated processes. New skills and competences for skilled production workers are presented in table 13.10.

- The circumstances of the “innovation-led” and “conservation” scenario are likely to require an increasing flexibility and re-skilling of production workers because of the introduction of new machines, materials (e.g. energy-saving building and insulation materials, special purpose materials) and procedures, the requirements for new product production within shorter innovation circles and more project-oriented work (innovation-led scenario). More complex and sophisticated products and machines also necessitate increasing analytical skills; this also holds for the “depletion” scenario.
- A growing number of production steps will be automated or computer-controlled, thus requiring improved e-skills and leading to a shift from manual production to increasingly mental dimensions of production work (e.g. controlling of machinery, supervision, programming etc.).
- Production will be confronted with an increasing number of regulatory obligations in the “conservation” and “Innovation-led” scenario that especially relate to security and environmental aspects. Quality management is also a relevant component.
- Team working skills, social perceptiveness. Communication, language and intercultural skills are likely to become more important even for production workers. As the number of women in production might rise, gender-related competencies may also become more required.

Table 13.10 Emerging skills and competences: Skilled production workers (2009-2020)

		Innovation-led scenario	Conservation scenario	Depletion scenario
Social Skills	Team working skills	■	■	
	Social perceptiveness	■	■	
	Communication	■	■	
	Networking			
	Language	■		
	Intercultural	■		
Problem solving skills	Analytical skills	■	■	
	Interdisciplinary			
	Initiative	■		
	Multi-skilling			
	Creativity	■	■	
Self management	Planning			
	Stress & time management	■	■	■
	Self-discipline	■	■	■
	Flexibility	■	■	■
	Multi-tasking			
Entrepreneurship	Understanding supplier & customers			
	Business development			
	Marketing skills			
	Trend setting / spotting			
Management skills	Strategic & visionary			
	Coaching & team building			
	Collegial management style			
	Change management			
	Project management			
	Process optimizing			
	Quality management	■	■	
Knowledge	Legislative & regulatory knowledge			
	e-skills	■	■	■
	Technical knowledge: -electronics -electricity -automation	■	■	■
Total emerging skills and competences		Count: 14	Count: 11	Count: 5

13.11 Plant and machinery repair and maintenance workers

Similar to the situation with production workers, plant and machine maintenance workers will foremost require hard technical and knowledge skills, but social skills will also become more relevant. Whereas the “status quo” scenario assumes no noteworthy changes, the other scenarios will require differences. In the “depletion” scenario, improvising skills may become an important factor since the acquisition of new machinery and materials is assumed difficult and older machinery has to be repaired, kept intact or improved with rather unorthodox means. The “conservation” scenario depicts a situation where especially energy efficiency and ecological considerations play an important role, thus necessitating more background knowledge from repair and maintenance workers. In the “innovation-led” scenario it is possible that machine-operators and maintenance workers will have to deal with new and different machinery in shorter time intervals and have to work in a more automated and software-based environment. New skills and competences for repair and maintenance workers are presented in table 13.11.

- The “innovation-led” scenario will put the machinery repair and maintenance workers under most pressure. The machines are likely to be more complex, have to meet strict safety and environmental requirements and regulations and involve more software, thus requiring constant skill updates and a growing amount of analytical and e-skills and especially legislative and regulatory knowledge. Insufficiently repaired and maintained machines will induce the most financial damage in this scenario.
- It is likely that in the “innovation-led” scenario machinery and maintenance workers will also be confronted with new special purpose machines or foreign models, necessitating interdisciplinary skills, teamwork, communication competency, multi-tasking and creativity. In fact, two futurepaths of development might apply: one with ‘old’ machines and ‘new’ products, and an even more complex one with ‘new’ machines and ‘new’ products.
- In the “innovation-led” scenario, also language and intercultural skills will become more relevant due to the overall global and more multicultural setting.

Table 13.11 Emerging skills and competences: Plant and machinery repair and maintenance workers (2009-2020)

		Innovation-led scenario	Conservation scenario	Depletion scenario
Social Skills	Team working skills			
	Social perceptiveness			
	Communication			
	Networking			
	Language			
	Intercultural			
Problem solving skills	Analytical skills			
	Interdisciplinary			
	Initiative			
	Multi-skilling			
	Creativity			
Self management	Planning			
	Stress & time management			
	Flexibility			
	Multi-tasking			
Entrepreneurship	Understanding supplier & customers			
	Business development			
	Marketing skills			
	Trend setting / spotting			
Management skills	Strategic & visionary			
	Coaching & team building			
	Collegial management style			
	Change management			
	Project management			
	Process optimizing			
	Quality management			
Knowledge	Legislative & regulatory knowledge (health,safety			
	e-skills			
	Technical knowledge: o health and safety o technical risk management			
Total emerging skills and competences		Count: 18	Count: 12	Count: 5

13.12 Labourers

Low educated workers (table 13.12) still make up a considerable part of the workforce in this sector which is currently defined as medium-low-technology industry (Hirsch-Kreinsen 2006). In all scenarios, unskilled labourers will be the losers due to rationalisation, automation, plant closure or general requirement for more higher-skilled workers. Low-skilled work in the manufacturing industry will also increasingly shift away from manual routines to more mental tasks like machine operation. However, supervision and controlling tasks partly require higher skilled production workers, leaving only little room for low-skilled labourers. Up-skilling may be a solution for part of the current workforce of labourers. Non-manufacturing low-skilled jobs like cleaning, catering or security will be increasingly delegated to other firms and service providers or even automated (cleaning and security robots). For the “depletion” scenario the pace of the scenario along with competition requires strong stress management skills and flexibility; rationalisation and strong competition lead to lay-offs which somehow need to be compensated by the remaining workforce.

- e-skills will become increasingly important for low-skilled workers as well as technical knowledge and analytical competencies.
- New products will require new production methods requiring more flexibility and multi-tasking capabilities of low-skilled workers
- Since it is plausible to assume that the number of non-European workers in low-skilled labour positions will be comparatively higher in all scenarios, certain intercultural sensitivity, language skills, communication and teamwork capabilities will be necessary.

Table 13.12 Emerging skills and competences: Labourers (2009-2020)

		Innovation-led scenario	Conservation scenario	Depletion scenario
Social Skills	Team working skills	■	■	
	Social perceptiveness			
	Communication	■	■	
	Networking			
	Language	■	■	■
	Intercultural	■	■	■
Problem solving skills	Analytical skills	■		
	Interdisciplinary			
	Initiative			
	Multi-skilling	■	■	
	Creativity			
Self management	Planning			
	Stress & time management			■
	Flexibility	■	■	■
	Multi-tasking	■	■	
Entrepreneurship	Understanding supplier & customers			
	Business development			
	Marketing skills			
	Trend setting / spotting			
Management skills	Strategic & visionary			
	Coaching & team building			
	Collegial management style			
	Change management			
	Project management			
	Process optimizing			
	Quality management	■	■	
Knowledge	Legislative & regulatory knowledge			
	e-skills	■	■	
	Technical knowledge	■	■	
Total emerging skills and competences		Count: 11	Count: 10	Count: 4

13.13 Conclusions on emerging skills and competences

- The “innovation-led” scenario is the most innovative, prosperous but also the most challenging in regard to new skills and knowledge requirements.
- A reform in the education system would be necessary to prepare future employees for the new challenges.
- Education and learning will not remain static. Once learned hard skills and knowledge may change and be outdated rather rapidly, especially in an Innovation-led growth setting.
- Knowledge and knowledge updating will be the most important factor in the future to generate economic growth and will increase productivity.
- The management and balancing between environmental quality, resource availability and growth in productivity will become a key challenge in the future.
- Specialisation as well as the competency to act within global frameworks and interdisciplinary settings requires skills that enable the employees to recognise where their specialisation may fit best in the overall context.
- The (scientific and technical) knowledge will change at a faster pace (in the “innovation-led” scenario) and requires constant knowledge updates.
- Just-in-time learning may be a solution especially for “upskilling” low-qualified/low-skilled workers.

Part III.

Available Options to Address Future Skills and Knowledge Needs, Conclusions and Recommendations

Part III. Available Options to Address Future Skills and Knowledge Needs and Recommendations - Guide to the reader

In the final third part of this report, a range of main strategic options (‘choices’) is reviewed, including possible actions in education and training. The report concludes with a number of conclusions and recommendations for the sector (individual firms, sector organizations, others) and policy-makers at various levels, ranging from the EU to the local level. Part III reflects steps 7 (Main strategic choices), 8 (Main implications for education and training) and 9 (Main recommendations) of the common methodology. Its contents are as follows: Chapter 14 highlights the various strategic choices in response to future skills and knowledge needs. Chapter 15 focuses on specific implications for education and training. Chapter 16 concludes by providing a number of key recommendations and conclusions.

14 Strategic choices to meet emergent skills and knowledge needs

14.1 Introduction

This chapter identifies the main strategic choices to meet the skills and knowledge needs identified (step 7). It provides a framework to pick and select the most relevant strategic choices – i.e. solutions to meet future skills and knowledge needs - available. Strategic choices refer and relate to the medium- and longer term, even though emerging skills needs in practice may also apply to the now and tomorrow. Essential in seeking appropriate solutions is to keep this longer time perspective in mind. Rather than focusing on one single solution, a set of linked strategic choices will in most cases be the best strategy to follow. Prioritising both in time (what first, where to follow up) and in allocation of resources (budgetary focus) followed by further fine-tuning is a clear necessity to guarantee that skills needs are targeted and solved. Skill needs can be identified at various levels, ranging from assessments at the national or even European sector level - which are by nature rather general - to more precise assessments at the regional and company level. Especially for large enterprises not only the identification of skills needs but also the search for adequate solutions will be an integral part of an overall longer-term business strategy. Some solutions will be found within the company itself, for instance by reorganising functions within or between plants, by offering (re)training trajectories and by active global sourcing of personnel. For SMEs and especially for micro-enterprises[18] such longer-term, more strategic human resource management often will be more difficult to organise and operationalise. It should be emphasized that at all possible levels identified different actors need to act to address skills needs and offer solutions and preferably also in close concert. These can be individual firms, organised interests at the sector level (employers and employees), but also others. Local, regional and national governments have also an important role to play. This chapter offers first of all a better insight in the 'menu' of possible strategic choices (section 14.2). It also provides for a framework that can identify skills needs at the appropriate level and helps to decide which should be the actual choices to be made (see section 14.3). This framework is subsequently applied to the non-metallic materials sector (section 14.4). For the sub-sectors the most plausible scenarios have been taken into account. For the glass and ceramics sub-sector the innovation-led growth scenario is most likely. In the building materials the conservation scenario is more probable.

14.2 Possible strategic choices

The possible strategic choices contained in this chapter refer to the strategic choices originally proposed by Rodrigues (2007: 42) as well as a number of other, additional choices. Whereas *strategic* choices mostly refer to the medium and longer term, most of the choices mentioned can also be implemented in the short run, to 'mend' existing skills shortages and/or skills gaps. Each of the solutions at hand differs in whether or not it can resolve direct skills shortages and/or gaps. A longer term horizon, however, means that there is possibility of adapting, steering and fine-tuning the available solutions towards a more optimal allocation of skills supply and demand. In view of the time horizon, the period up to 2020, the strategic choices and instruments with a more long-term impact especially need to be addressed. Identification of possible solutions obviously is not enough. Concrete initiatives, policy and

[18] Defined as firms with less than 10 employees.

strategic decisions need to be taken at all appropriate levels with each actor having a different responsibility and a different role to play.

Strategic choices to meet future skills needs, need to be taken by a number of actors and at different levels (firm, local, regional, national, sectoral). For obvious reasons, firms are an important player in finding solutions for the skills needs – both in volume (skills shortages) and in matching any existing skills gaps. Companies avail of a number of options to meet their skills needs. These include:

A. Recruiting workers from other sectors
B. Recruiting workers from other Member States
C. Recruiting workers from non-Member States
D. Recruiting unemployed workers with or without re-training
E. Recruiting young people coming from the education system, with or without re-training (first job recruits)
F. Training employed workers
G. Changing the work organisation (including network collaboration and mergers)
H. Outsourcing and offshoring.

Sectoral organisations, educational institutions and governments also have a role to play. They will be the prime actors in addressing the following options:

I. Changing general and vocational education
J. Designing and offering new courses (continuing vocational education and training)
K. Providing information about jobs and (emerging) skills: career guidance; updating job profiles regularly.
L. Improve the image of the sector (joint action of companies together)
M. Stronger cooperation with the industry (internships, company visits for participants in education, image improvement).

A more detailed description of these strategic options can be found in annex III. Whether these strategic options are feasible and viable depends on a number of factors. In order to discuss and select from the available list of strategic options, one should first - as described in the introduction - know whether and when skills needs are indeed likely to arise, both in quantitative (number of job functions) and in qualitative terms (what knowledge and skills). An important question that needs to be addressed first is at what level and to whom the skills needs question applies. Obviously for an individual firm different information is required for identifying these needs and taking the right action than for a national ministry or a training institute.

The identification of possible strategic choices would in principle require extensive and detailed future analysis at the Member State and preferably also the regional level of skills and knowledge demand and supply patterns by job function and sub-sector, in a similar way and along the steps provided by the methodology of this study so far. The methodology and step-wise approach followed are applicable at the national and regional level of analysis. Ideally, these results should be complemented by the results of labour market model forecasts to corroborate results. Such an analysis would also need to include an assessment of the numbers and skills composition of currently being educated, i.e. an assessment of all cohorts of primary, secondary and tertiary pupils and students (and their skills potential) currently in the educational system and arriving at the labour market in the oncoming years. It would need a thorough assessment of the current educational and training system itself, including the already decided changes herein for the oncoming years, to see whether the system as it is now

in place is able to satisfy the prevailing and future new skills demands both in terms of numbers of new potential recruits and in terms of skills and knowledge.

14.3 Matching future skills and knowledge needs by making the right choices

In order to address the identified future skills and knowledge needs in an encompassing and timely manner, appropriate joint action is needed by all stakeholders, including the industry (firms, sector organisations and social partners), training and education institutes, intermediary organisations and, last but not least, government at all levels (EU, national, regional and local). Collaboration and co-operation between stakeholders will be needed, at all decision-making levels, in order to agree on and implement a package of feasible solutions. In order to prepare for this, timely, targeted and reliable information is essential.

This section presents a targeted short-cut strategic options decision tool to enable and support decision-makers in making the right (mix of) choices, supported by appropriate and reliable information on actual needs, possible choices and stakeholders to be involved. The strategic options decision tool is aimed to provide answers and solutions at the job function level and consists of a shortlist of a number of key questions - a concise menu of choice -, with answers providing decision-relevant information about the need and viability of available options. The questions need to be answered at the national, and where relevant at the regional level so as to map and identify the specific sector needs. The decision tool can also be used at the level of the firm. New job function information (e.g. new upcoming functions) can be added where thought relevant.

The key question list – consisting of six ‘framing’ questions, followed by option-specific questions - should be filled in for each job function. The ‘framing’ questions constitute a summary of main expected quantitative and qualitative skills needs developments. The filling in of the list should, however, only be done on the basis of an informed discussion between several stakeholders involved, representing together an informed body of knowledge on the various aspects at stake, including labour market developments and prospects at the sub-sector level, skill and knowledge requirements at job function level and developments in and make up/orientation of the educational and training system.

Key questions for identifying skills and knowledge needs

Question 1. Is the demand for workers expected to decrease or increase between now and 2020? (both related to market prospects and replacement demand due to ageing)

> If decreasing, there is probably less need for recruiting workers from other sectors and (non-) Member States and less need for recruiting unemployed.
>
> If increasing, analyse whether less radical options are enough to meet demand or whether options should be chosen like recruiting workers from other sectors and (non-) Member States and recruiting unemployed. *[Note: see Table 12.1 for estimated volume effects per scenario.]*

Question 2. Are the required qualitative skills expected to be rather stable between now and 2020?

> If there are not many changes in required skills and knowledge, there is probably no need to apply many strategic options. Please focus on the options that are most effective.
>
> If many skills and knowledge categories are changing, there is probably a need to apply many strategic options. Create a package of strategic options to meet skill needs.

[Note: see Table 13.2 and following for the number of competences changing per job function per scenario.]

Question 3. Do SMEs and especially small companies (including micro enterprises) play a large role in the sector?

If yes, several options (like recruiting) are less viable for companies themselves as it is often difficult for small companies to organize this. If this is the case, sector organisations or intermediary organisation might play an important role in helping to match supply and demand. Another solution could be found in changing the work organisation. Through cooperation or mergers, for instance, the relevant scale can be increased which makes it easier to use these options. The same holds, more or less, for the organisation of training and re-training. Larger (associations of) companies have less difficulties to organise this and the need for support from other actors is lower. *[Note: see Table 3.7 for number of firms per size class.]*

Question 4. Are companies in general active on Member State level, EU level or global level?

Companies who are active on a larger regional level will have, in general, more opportunities to use the option of recruiting workers from other Member States (for companies active at the EU level) and the option recruiting workers from non-Member States (for companies active at the global level). The same holds for the option offshoring. *[Note: see chapter 6]*

Question 5. Are workers in a job function in general low-educated?

If yes, training is less easy to implement as a viable option as difficulties arise in organising this, while the need for training might be even higher. *[Note: see Table 3.8 to 3.10, for education shares]*

Question 6. Are workers in a job function in general old (i.e. older than the average age in the sub-sector and compared to other sectors)? *[Note: see section 3.3, for age structure.]*

If yes, training is less easy to implement as a viable option as difficulties arise in organising this and less new knowledge endogenously enters the companies, while the need for training might be even higher.

Key questions for identifying suitable options and relevant acting stakeholders

The six questions form the first part of the short-cut approach. The second part discusses the viability of strategic options to tackle and solve emergent skills and knowledge needs for each of the job functions identified. It confronts the list of available strategic options with the analysis of quantitative and qualitative developments on headlines based on the preceding six questions. For each job function identified an assessment is made on whether the available strategic options are relevant or not, and who should be prime actors to change the current situation into a more favourable direction. If the strategic option is considered relevant, a “yes” is filled in, else a “no” is included. If the strategic option is dependent on specific characteristics of the sub-sector or components thereof, this is included in the table. For example, if recruiting workers from other Member States is only an option for large companies a “Yes, but only for large companies” will be included. Characteristics that are dealt with in the table are based on the six question analysis, representing:

- The change in volume (as a reference we include the most challenging scenario in terms of change required)
- The change in skills (as a reference we include the most difficult scenario, which is often the scenario with the largest change in skills and knowledge needs)

- Education level
- Age of the workforce
- Scale of the company and region the company is working in.

In principle, the following tables can be made scenario-dependent. In the descriptions below, the *Innovation-led scenario* has been taken as the point of reference as the most demanding and dynamic in terms of up-skilling, knowledge upgrading and change.[19]

14.4 Managers

Table 14.1 presents the viable strategic options for emergent competences of managers in the non-metallic materials sector.

Within the glass and ceramics sub-sector the 'Innovation-led growth' scenario is the most challenging and promising for the near future. 'Innovation-led growth' will bring a shift from standard and routine production to more high-value products and internationalisation. Managers of European origin may be increasingly required from companies and partners outside the EU. The demand for managers in Europe will increase as a result of a growing number of employees.

In the 'Conservation' scenario of the building materials sub-sector a combination of a declining trend due to ongoing increases in scale and the need to have additional managers who can deal effectively with a changing regulatory environment, the number of managers is expected to remain stable.

As a result of these developments there will only be a limited recruitment of managers in both sub-sectors in the near future (only replacement). Only when companies start new production sites in other countries (within or outside the European Union) recruitment of managers will be necessary in these countries.

In formulating a recruitment strategy that is aimed at pulling in new managers firms should broaden their recruitment horizon and also aim at for instance female management potential. The non-metallic materials sector is still a 'white males' sector. A characterization that does not appeal to the female workforce that offers management, sales and marketing potential. Recruitment of young people is a viable option, but well developed traineeships or apprenticeships are necessary and the sector could specifically target female.

New recruits need to be trained or would need to build experience in order to gain sector specific skills, such as a more profound understanding of consumer and supplier needs as well as business developing skills in addition to managing and process optimizing skills. The latter is slightly more important in the global specialization scenario than in the regionalization scenario, since more professionals are needed.

[19] The strategic options for the following job functions were validated and complemented where necessary at the final workshop: engineers & R&D personnel, sales & marketing, skilled production workers, plant and machinary repair workers

Table 14.1 Strategic options Managers

1. What is the maximum volume effect?	Maintain in both sub-sectors
2. What is the maximum change in skills?	17
3. Do SMEs play a large role?	Yes (glass+ceramics)/No (building materials)
4. Is the sector national/EU/global?	Global (glass+ceramics)/EU (building materials)
5. Is the workforce old?	Yes
6. Is the workforce low educated?	No

Option	**Is this option viable?**	**Actors[1]**
A. Recruiting workers from other sectors	Yes, mainly for generic management skills	C, S, I
B. Recruiting workers from other Member States	Yes, when production sites have been offshored to/new productions sites have been established in these Member States	C, I
C. Recruiting workers from Non-Member States	Yes, when production sites have been offshored to/new productions sites have been established in these countries	C, I
D. Recruiting unemployed with or without re-training	No	-
E. Recruiting young people from the education system	Yes, mainly through apprenticeships, sector ambassadors in schools, use 'sustainability' image	C, S, E
F. Training and re-training employed workers	Yes, in-house promotion and further training in the firm	C, S, E
G. Changing work organisation	Yes, introduction new management concepts, self steering teams and flexible organisation concepts	C
H. Outsourcing and offshoring	Yes (glass and ceramics)/No (building materials)	C
I. Changing vocational education	New management concepts	S, E
J. Designing and offering new courses	Yes, emerging skills (such as ….)	S, E
K. Providing information about emerging skills	Yes	S, E, G
L. Improve the image of the sector	Yes, especially building materials image in recruiting young workers and diverse target groups (female, ethnic minorities)	C, S
M. Stronger cooperation between stakeholders	Partners in the value chain (glass and ceramics)/ partners in the supply chain (building materials)	C, S, E, I, U

Notes: 1. C (company), S (sector organisations and chambers of commerce), E (education & training), G (governments), I (intermediary organisation, public or private), U (Trade Unions).

14.5 IT Professionals

In the innovation-led growth scenario of the glass and ceramics sector the demand for ICT-related jobs will generally increase and a focus on high-end and speciality products will necessitate closer cooperation with the customers. However the number of ICT-jobs in this sector will not increase as a result of outsourcing and offshoring.

Table 14.2 presents the viable strategic options for emergent competences of IT/ Computer Professionals in the non-metallic materials sector.

The number of jobs in the building materials sector is expected to be stable in the conservation scenario. Even a small decrease in the number of IT jobs is possible as a result of outsourcing and offshoring.

Training programmes should mainly be aimed at the users of modelling and simulation software as the largest benefits for firms are expected here. All strategic options appear more viable for large companies, since these companies require more of the skills sets mentioned.

Table 14.2 Strategic options IT professionals

1. What is the maximum volume effect?	Maintain or decrease
2. What is the maximum change in skills?	15
3. Do SMEs play a large role?	No
4. Is the sector national/EU/global?	Global (glass+ceramics)/EU (building materials)
5. Is the workforce old?	No; even younger in NMS
6. Is the workforce low educated?	No

Option	**Is this option viable?**	**Actors**[1]
A. Recruiting workers from other sectors	Yes (transport sector for experiences with IT on logistics)	C, S, I
B. Recruiting workers from other Member States	No	-
C. Recruiting workers from Non-Member States	No	-
D. Recruiting unemployed with or without re-training	No	-
E. Recruiting young people from the education system	Yes, IT skills (knowledge) readily available. Competition is fierce, however.	C, E
F. Training and re-training employed workers	Yes, but maybe difficult for older workers (lacking IT based education/ affinity). Viable for project management skills, stress and time management skills)	C, S, E, U
G. Changing work organisation	Telework , flexwork	C, I,U
H. Outsourcing and offshoring	Yes, in house IT support will be outsourced	
I. Changing vocational education	Yes, integrating IT skills and technical knowledge	C, S, E
J. Designing and offering new courses	Yes, mainly aimed at specific IT solutions to the sector (modelling/ simulation of processes). Integrating IT skills and technical knowledge	C, S, E
K. Providing information about emerging skills	Yes	S, E, G, U
L. Improve the image of the sector	Yes, especially building materials image in recruiting young workers and diverse target groups (female, ethnic minorities)	C, S, U
M. Stronger cooperation between stakeholders	Especially with organisations that employ the outsourced employees	C, S, E, I, U

Notes: 1. C (company), S (sector organisations and chambers of commerce), E (education & training), G (governments), I (intermediary organisation, public or private), U (trade unions).

14.6 Other professionals

The group of other professionals (table 14.3) which includes economists and law professionals, as well as new job occupations in the sector like environmental specialists and agronomists working on socio-economic and organizational issues in sustainability and a 'greener' image is expected to grow in the 'Innovation-driven growth' and 'Conservation' scenarios and to stabilize under the 'Resource depletion' scenario.

Recruiting from other sectors might be an option especially for the construction materials sub-sector, especially from the minerals and oil and gas sectors – which operate in similar market environments. Recruiting workers from other Member States is a viable option, as consolidation in the sector, also in glass and ceramics, is likely to continue. This is, however, less of an option for small- and micro-enterprises. Hiring personnel from third countries might especially be an option for the large multinational companies, as their scope of operation might broaden further (e.g. new markets but also offshoring as a result of CO2 ETS impacts in the cement industry).

Recruiting young people from the education system is an option where the relative new job occupations of environmental specialists and agronomists are concerned, especially in construction materials. Special training and courses, especially in the 'Innovation-led' scenario, might be set up to provide the necessary additional background on new markets (China and India), environmental economy and legislation, patent law, copyright protection, norms and standards and reliability/claim management. In the "conservation" scenario, the emphasis would have to lie more on environmental and energy aspects and EU-regulations. In both scenarios interdisciplinary competencies should be further strengthened, through training on-the-job and possibly also in the regular vocational training.

Table 14.3 Strategic options Other Professionals (2009-2020)

1. What is the maximum volume effect?	Increase (especially in the innovation driven and conservation scenarios) in EU15 and NMS	
2. What is the maximum change in skills?	13	
3. Do SMEs play a large role?	Yes (glass) Large companies ceramics) / No (building materials)	
4. Is the sector national/EU/global?	Global (glass+ceramics+building materials)	
5. Is the workforce old?	Medium	
6. Is the workforce low educated?	No	
Option	**Is this option viable?**	**Actors[1]**
A. Recruiting workers from other sectors	Yes, esp. in construction, and most likely only in large and medium enterprises.	C
B. Recruiting workers from other Member States	Yes, but mainly in the innovation driven scenario, difficult for SMEs	C, S, E, I
C. Recruiting workers from Non-Member States	Yes, but mainly for large companies; yet difficult not for SMEs; governments should take action to simplify legal regulations which function as barrier	C, S, E, I, G
D. Recruiting unemployed with or without re-training	Very limited option	C
E. Recruiting young people from the education system	Yes, aim at emerging skills and competences, and new job profiles (sustainability/eco-related)	C
F. Training and re-training employed workers	Yes, interdisciplinary courses, knowledge-oriented esp. for lawyers	C, S, I, E, U
G. Changing work organisation	Yes, interdisciplinary team work, but limited so in SMEs	C, I, U
H. Outsourcing and offshoring	Yes, offshoring, mainly for large companies (not for core business) and mainly in construction materials	C
I. Changing vocational education	Yes, focus more on interdisciplinary skills, as well as language and intercultural skills.	C, S, E
J. Designing and offering new courses	Yes, especially in environmental economy and legislation, patent law, copyright protection, norms and standards and reliability/claim management.	C, S, E
K. Providing information about emerging skills	Yes	C, S, E, G, U
L. Improve the image of the sector	Yes, especially among women and other target groups (ethnic minorities)	C, S, I, U
M. Stronger cooperation between stakeholders	Yes, interdisciplinary education & training organisation	C, S, E, G, U

Notes: 1. C (company), S (sector organisations and chambers of commerce), E (education & training), G (governments), I (intermediary organisation, public or private), U (trade unions).

14.7 Engineers and R&D personnel

Engineers are the most important job category for growth in the non-metallic materials sector in the (near) future. In the conservation scenario of the building materials sector the restructuring of operation and plant modernisation in the frame of environmental improvement is the source of the growth of the demand for engineers. In the glass and ceramics the increase will go together with a focus on high-end and speciality products, which make a closer cooperation with the customers more necessary.

Table 14.4 presents the viable strategic options for emergent competences of engineers in the non-metallic materials sector. Almost all strategic options mentioned in the table are considered more or less viable. For this job function recruiting workers from other sectors is more difficult because potential engineers in the non-metallic materials sector require specific technical skills and competences. Recruitment from other states, especially Member States, is a viable option. From non Member States this might be more difficult with higher cultural and language barriers But an intercultural workforce might also open up new possibilities in terms of market access. Recruiting unemployed is no viable option, normally lacking the competences required to work as an engineer.

Recruitment of young people through well developed technical traineeships (or courses) is another option. Interdisciplinary learning and understanding of clients and suppliers should receive attention. These training packages should also be made available (tailored) for older workers to retrain them.

One option related to changing work organisation is to reduce the number of job profiles is a way to stimulate mobility within the firm, but also to improve interdisciplinary work.

Table 14.4 Strategic options Engineers and R&D personnel

1.What is the maximum volume effect? 2. What is the maximum change in skills? 3. Do SMEs play a large role? 4. Is the sector national/EU/global? 5. Is the workforce old? 6. Is the workforce low educated?	Increase (especially in the glass and ceramics in the innovation driven scenario) in EU15 and NMS 24 Yes (glass) Large companies ceramics) / No (building materials) Global (glass+ceramics+building materials) Medium No	
Option	**Is this option viable?**	**Actors[1]**
N. Recruiting workers from other sectors	Yes, but not most preferred as company or sector specific skills and competences are needed.	C
O. Recruiting workers from other Member States	Yes, but mainly in the innovation driven scenario, difficult for SMEs	C, S, E, I
P. Recruiting workers from Non-Member States	Yes, but mainly for large companies;yet difficult for SMEs; governments should take action to simplify legal regulations which function as barrier	C, S, E, I, G
Q. Recruiting unemployed with or without re-training	Very limited option	C
R. Recruiting young people from the education system	Yes, aim at emerging skills and competences	C
S. Training and re-training employed workers	Yes, interdisciplinary courses, language/ intercultural skills and understanding customer supplier; managerial skills	C, S, I, E, U
T. Changing work organisation	Yes, interdisciplinary team work, job enlargement and enrichment, but limited in SMEs	C, I, U
U. Outsourcing and offshoring	Yes, both viable, mainly for large companies (not for core business)	C
V. Changing vocational education	Yes, focus on good basic technical education,with more emphasis on math,chemistry and physics. Including language, intercultural and entrepreneurial skills.	C, S, E
W.Designing and offering new courses	Yes, especially for technical specialists, based on emerging skills and competences; managerial courses to be included in engineering curricula	C, S, E
X. Providing information about emerging skills	Yes	C, S, E, G, U
Y. Improve the image of the sector	Yes, especially building materials image in recruiting young workers and diverse target groups (ethnic minorities)	C, S, I, U
Z. Stronger cooperation between stakeholders	Yes, interdisciplinary education & training organisation	C, S, E, G, U

Notes: 1. C (company), S (sector organisations and chambers of commerce), E (education & training), G

(governments), I (intermediary organisation, public or private), U (trade unions).

14.8 Accounting & Finance

In the innovation led-growth scenario of the glass and ceramics sub-sector the number of accounting staff with European origin might decrease due to growing outsourcing and offshoring tendencies of back office activities as a result of globalisation. Still we expect a small increase of Accounting and Finance jobs within this sector

In the conservation scenario the building materials sub-sector is confronted with the overall increase in scale in operations. This is combined with a shutdown of more polluting factories and involves a slight decline in the number of accounting and financial employees in this sector.

Some accounting and finance emergent skills, such as legislative and regulatory knowledge of an international nature, are of a generic nature and can be recruited from other sectors. The same goes for e-skills. The latter set of skills is of a generic nature. They can be recruited in other sectors, in other countries and among young people. Although the need for accounting and finance professionals is expected to be modest in the glass and ceramics sub-sector, replacing employees that leave the labour market will be necessary and recruiting these skills from other sectors is a viable option. Recruiting accounting and finance skills from other states within or outside the EU can pose difficulties, since regulatory and legislative knowledge are often country-specific. Recruiting these skills from other Member States is a viable option for operations in the home state of recruits. Recruiting skills for other countries or markets than the home market of the recruit would be a less viable option. To make recruitment activities in other states more viable training programmes can be developed that provide recruits with an international set of skills and knowledge of international laws and rules. The EU could help in standardizing international rules and laws, potentially improving labour mobility. Strategic options for accounting and finance staff are presented in table 14.5.

Table 14.5 Strategic options Accounting & Finance

1. What is the maximum volume effect?	Increase (glass+ceramics)/decrease (building mat.)
2. What is the maximum change in skills?	11
3. Do SMEs play a large role?	No
4. Is the sector national/EU/global?	Global (glass+ceramics)/EU (building materials)
5. Is the workforce old?	Yes
6. Is the workforce low educated?	No

Option	**Is this option viable?**	**Actors[1]**
A. Recruiting workers from other sectors	Yes, mainly generic skills involved (business, finance, law)	C
B. Recruiting workers from other Member States	Yes, absolutely necessary if expanding business in specific Member States (knowledge of local laws)	C, S, E, I
C. Recruiting workers from Non-Member States	Less necessary, but a viable option	C
D. Recruiting unemployed with or without re-training	No, too low educated	
E. Recruiting young people from the education system	Yes, e-skills and up to date legislative and regulatory knowledge needed.	C, S
F. Training and re-training employed workers	Yes, when expanding local regulations. May be difficult for older workers	C, E, U
G. Changing work organisation	Not viable	
H. Outsourcing and offshoring	Yes outsourcing	C
I. Changing vocational education	Yes continuous change needed as a result of new regulations/legislation	C, S, E
J. Designing and offering new courses	Yes continuous change needed as a result of new regulations/legislation	C, E, S
K. Providing information about emerging skills	Yes	C, S, I, U
L. Improve the image of the sector	No	
M. Stronger cooperation between stakeholders	Yes, especially with organisations with employ outsourced employees	C, S, I, G, U

Notes: 1. C (company), S (sector organisations and chambers of commerce), E (education & training), G (governments), I (intermediary organisation, public or private), U (trade unions).

14.9 Sales & Marketing

Table 14.6 presents viable options for the sales & marketing functions.

In the innovation led growth scenario an increasing number of new products will be developed in the glass and ceramics sub-sector. These new products need to be introduced, advertised and marketed. This will increase the demand for sales and marketing jobs.
In the building materials sector the negative (polluting) image among the consumers has to be improved. Sales and marketing should help to show the public the new environmental friendly attitude of the sector. This will counterbalance the decline in sales and marketing jobs as a result of offshoring more polluting production plants.

Recruitment of workers from other sectors is a limited strategic option for the non-metallic materials sector, because product and commercial knowledge has become more and more important in this job function. New recruits will need to be trained on the job in order to gain a more profound understanding of consumer and supplier needs.

In formulating a recruitment strategy that is aimed at pulling in workers from other countries (inside or outside the EU), as well as for pulling in young people, firms should broaden their recruitment horizon and also aim at for instance female workers. The non-metallic materials sector is still a ‘white males’ sector. A characterization that does not appeal to the female workforce that offers sales and marketing potential. Positive action is required also in recruiting workers from other sectors. Training courses need to be developed for sales & marketing functions in order to provide workers with up to date product knowledge. A focus in these courses would be on technical product specifications and translating these for clients in different markets and countries.

Recruiting young people is a further viable option especially related to up-to-date e-skills. Young people are used to work with IT and will be able to learn these skills more quickly than older workers. Also, young people often possess more intercultural and language skills as they grew up in a more mixed society/ school environment.

Table 14.6 Strategic options Sales & Marketing

1. What is the maximum volume effect?	Increase (glass+ceramics and building materials B2C)/maintain (building materials B2B)
2. What is the maximum change in skills?	21
3. Do SMEs play a large role?	No;Yes for glass (flat glass, domestic/artistic glass)
4. Is the sector national/EU/global?	Global (glass+ceramics)/EU (building materials)
5. Is the workforce old?	No, workforce age is average
6. Is the workforce low educated?	No,but education too generic(more training needed)

Option	**Is this option viable?**	**Actors[1]**
A. Recruiting workers from other sectors	Yes, since product and commercial knowledge is becoming more and more important in this job function.	C
B. Recruiting workers from other Member States	Yes, but limited since country specific knowledge is necessary in marketing. Absolutely necessary strategy however if expanding business in specific Member States	C, S, E, I, G
C. Recruiting workers from Non-Member States	Yes, but limited since country specific knowledge is necessary in marketing. Absolutely necessary strategy however if expanding in specific Non-Member States	C, S, E, I, G
D. Recruiting unemployed with or without re-training	No	-
E. Recruiting young people from the education system	Yes, esp. for people coming from universities (BAs)	C, E, S
F. Training and re-training employed workers	Yes, continuous training business development. Networkofsimuklation companies aimed at middle management	C, E, S, I, U
G. Changing work organisation	No	-
H. Outsourcing and offshoring	Yes, outsourcing market research	C, S
I. Changing vocational education	Innovations in sales and marketing; IT and technical knowledge	C, S, E, G
J. Designing and offering new courses	Yes, mainly sector specific modules in product knowledge (technical understanding), and creativity ansd design	C, S, E,G
K. Providing information about emerging skills	Yes	C, S, I (G), U
L. Improve the image of the sector,and address challenges (environment, CSR, energy conservation)	Yes, especially sustainability image in recruiting young workers and diverse target groups (female, ethnic minorities)	C, G, media, U
M. Stronger cooperation between stakeholders	Yes, especially building materials B2C with consumer organisations and retailers	C, S, E, I, U
Notes: 1. C (company), S (sector organisations and chambers of commerce), E (education & training),		

G (governments), I (intermediary organisation, public or private), U (trade unions).

14.10 Administrative support staff

In table 14.7 strategic options for emergent competences related to support staff are presented.

The need for administrative support staff is declining in the non-metallic materials sector. In the glass and ceramics sub-sector growing outsourcing and offshoring tendencies of back office activities in the innovation led growth scenario involve a decrease in the number of administrative staff with European origin. In the building materials sub-sector the conservation scenario leads to a shutdown (or offshoring) of more polluting factories, which has a slightly negative effect on the demand of administrative support staff.

As a result of these developments recruiting activities can be limited to young people from the education system. These new employees should be used to replace employees that leave the labour market and to ensure the import of new administrative concepts and methods in the organisations. The sector could work together with educational institutions and sector organisations to develop a basic technical training for support staff.

Table 14.7 Strategic options Administrative support staff

1. What is the maximum volume effect?	Decrease (as a result of IT developments and outsourcing)
2. What is the maximum change in skills?	11
3. Do SMEs play a large role?	No
4. Is the sector national/EU/global?	Global (glass+ceramics)/EU (building materials)
5. Is the workforce old?	Yes
6. Is the workforce low educated?	Mainly

Option	**Is this option viable?**	**Actors[1]**
A. Recruiting workers from other sectors	No	-
B. Recruiting workers from other Member States	No	-
C. Recruiting workers from Non-Member States	No	-
D. Recruiting unemployed with or without re-training	No	-
E. Recruiting young people from the education system	Yes, e-skills, language and intercultural skills readily available	C, E
F. Training and re-training employed workers	Yes, training planning, team working and communication skills, as well as e-skills (basic internet/ spreadsheet and word processing)	C, E, U
G. Changing work organisation	Yes (team work, job enlargement and enrichment)	C, I
H. Outsourcing and offshoring	Yes, mainly outsourcing	C
I. Changing vocational education	Not necessary	-
J. Designing and offering new courses	Not necessary	-
K. Providing information about emerging skills	Not necessary	-
L. Improve the image of the sector	Not necessary	-
M. Stronger cooperation between stakeholders	Shared Services	C, S, I, U

Notes: 1. C (company), S (sector organisations and chambers of commerce), E (education & training), G (governments), I (intermediary organisation, public or private), U (trade unions).

14.11 Truck drivers

In the non-metallic materials sector two developments are dominant in the future for transport jobs. Many truck driver jobs will be taken over by transport companies in low wages countries (southern and eastern Europe), because costs of transport are an important competitive factor in international markets. At the same time transport by road will be discussed from an environmental perspective and alternatives will be encouraged by the European Union and by environmental pressure groups. The sector can use a more positive environmental image and will actively search for transport alternatives, e.g. by train.

In the conservation scenario for the building materials sector the demand for truck drivers is likely to decline due to a concentration on more successful plants and an overall political emphasis on environmental sustainability.

In the 'Innovation-led growth' scenario of the glass and ceramics sector globalisation will lead to a growing demand for transport. Nevertheless the number of truck drivers may remain the same or even decrease because companies will increasingly use alternatives to road transport. Also in the conservation scenario companies will surge for other transport facilities than road transport.

Table 14.8 presents strategic options for emergent competences related to truck drivers.

Table 14.8 Strategic options Truck drivers

1. What is the maximum volume effect?	Maintain or decrease (glass and ceramics)/decrease (building materials)
2. What is the maximum change in skills?	9
3. Do SMEs play a large role?	No
4. Is the sector national/EU/global?	Global (glass+ceramics)/EU (building materials)
5. Is the workforce old?	Average
6. Is the workforce low educated?	Yes

Option	**Is this option viable?**	**Actors[1]**
A. Recruiting workers from other sectors	No	-
B. Recruiting workers from other Member States	Yes	-
C. Recruiting workers from Non-Member States	No	-
D. Recruiting unemployed with or without re-training	No	-
E. Recruiting young people from the education system	?	-
F. Training and re-training employed workers	No	-
G. Changing work organisation	No	-
H. Outsourcing and offshoring	Outsourcing	C
I. Changing vocational education	Yes, drivers need more environmental qualifications	C, S, E
J. Designing and offering new courses	Yes, drivers need more environmental qualifications	C, S, E
K. Providing information about emerging skills	-	-
L. Improve the image of the sector	-	-
M. Stronger cooperation between stakeholders	-	-

Notes: 1. C (company), S (sector organisations and chambers of commerce), E (education & training), G (governments), I (intermediary organisation, public or private), U (trade unions).

14.12 Skilled production workers

Two scenarios are possible for the building materials sub-sector in the conservation scenario. On the one hand the restructuring and modernisation of the industry and the introduction of innovation may call for more specialised production workers. On the other hand, scale increases and the shutdown of more inefficient and pollutant plants together with rationalisation efforts may reduce the demand for skilled production workers.
In the innovation led growth scenario the requirement for skilled workers in the glass and ceramics sub-sector will be stable. European experts and skilled workers will be needed abroad (e.g. in China, India and the Middle East) as consultants and trainers. This will be especially the case when emerging countries are also beginning to adopt stricter environmental legislation.

Another development which involves the skilled production workers in the non-metallic productions sector is the need to upgrade the technical skills. Closing (or offshoring) strongly polluting production plants and improving the environmental character of the processes ask for more environmental knowledge and more generally speaking an upgrade from low tech skills to high tech skills. At the same social skills become increasingly more important.

Table 14.9 presents the related strategic options. Recruiting technical knowledge in other sectors is difficult making hiring from other sectors a low priority. Similarly, recruiting from other states is also a less viable option due to hiring costs and differences in HSE regulation. The EU could facilitate intersectoral and international labour mobility, however, by standardising safety standards together with the industry.

With technical knowledge of key importance on the job, training courses preparing workers for new more environmental friendly technologies are needed to keep technical skills up-to-date. With differences in learning these should be adapted for younger and older workers. Recruiting young people through vocational training systems is an important strategic option. However, the sector needs to stimulate the interest in schools in technical and science related subjects for people to bring with them the necessary technical understanding for working in a science based industry.

Table 14.9 Strategic options Skilled production workers

1. What is the maximum volume effect?	Maintain
2. What is the maximum change in skills?	14
3. Do SMEs play a large role?	Yes, large role
4. Is the sector national/EU/global?	Global (glass+ceramics)/EU (building materials)
5. Is the workforce old?	Medium
6. Is the workforce low educated?	No

Option	**Is this option viable?**	**Actors[1]**
A. Recruiting workers from other sectors	Limited, since upskilled product knowledge is becoming more and more important in this job function.	C, E ,I
B. Recruiting workers from other Member States	Limited, only when business is extended or offshored to specific Member States (language limits option)	C, S, E, I, G
C. Recruiting workers from Non-Member States	Limited, only when business is offshored to Non-Member States (language problems)	C, S, E, I, G
D. Recruiting unemployed with or without re-training	No	-
E. Recruiting young people from the education system	Yes, especially important because the education level of workers needs to be upgraded	C, E
F. Training and re-training employed workers	Very important to upgrade the skills level of the current workers	C, E, U
G. Changing work organisation	Yes, intertwined with new and less polluting technologies in production processes; from Taylorist work processes to self steering teams	C, I
H. Outsourcing and offshoring	Offshoring (processes and production in polluting plants): no; outsourcing: yes.	C
I. Changing vocational education	Yes; related to production (processes) based on new and less polluting technologies (renewables).	C, S, E
J. Designing and offering new courses	Yes; related to production (processes) based on new and less polluting technologies (renewables).	C, S, E
K. Providing information about emerging skills	Yes	C, S, I, U
L. Improve the image of the sector	Yes, especially to young people.	C, S, U
M. Stronger cooperation between stakeholders	Yes	C, S, E, G, I, U

Notes: 1. C (company), S (sector organisations and chambers of commerce), E (education & training), G (governments), I (intermediary organisation, public or private), U (trade unions).

14.13 Plant and machinery maintenance and repair workers

Although the need for plant, machinery maintenance and repair workers in the conservation scenario of the building materials sector and in the innovation led growth scenario of the glass and ceramics sector is growing, this need will not be covered by an increase in these jobs within this industry. This is a result of the outsourcing processes for plant, machinery maintenance and repair jobs, which are expected in the non-metallic materials sector.

Table 14.10 presents strategic options for emergent competences related to plant and machinery repair and maintenance. Only limited recruiting activities will be necessary when business is extended or offshored to other countries (inside or outside the EU). Additionally, new young people can be recruited from the education system. These new employees should be used to replace employees that leave the labour market. The sector could work together with educational institutions and sector organisations to develop a basic technical training for machinery maintenance and repair staff.

Table 14.10 Strategic options Plant and machinery maintenance and repair workers

1. What is the maximum volume effect?	Decrease as a result of outsourcing processes
2. What is the maximum change in skills?	18
3. Do SMEs play a large role?	No
4. Is the sector national/EU/global?	Global (glass+ceramics)/EU (building materials)
5. Is the workforce old?	No
6. Is the workforce low educated?	No

Option	**Is this option viable?**	**Actors[1]**
A. Recruiting workers from other sectors	No,because highly specialised.	-
B. Recruiting workers from other Member States	Limited, only when business is extended or offshored to specific Member States. Also in certain operations requit\ring specific skills.	C, S, E, I
C. Recruiting workers from Non-Member States	Limited, only when business is offshored to Non-Member States	C, S, E, I
D. Recruiting unemployed with or without re-training	No	-
E. Recruiting young people from the education system	Yes	C, E
F. Training and re-training employed workers	Yes, new knowledge	C, S, U
G. Changing work organisation	No	-
H. Outsourcing and offshoring	Yes, outsourcing of repair and maintenance to specialist firms. Depending size company and degree specilaisation/confidentiality	C
I. Changing vocational education	Yes, renew technical knowledge in training (new materials)	C, S, E, G
J. Designing and offering new courses	Yes, on new materials, new regulations	C, S, E
K. Providing information about emerging skills	Yes	C, S, I, U
L. Improve the image of the sector	Yes, especially to young people.	C, S, U
M. Stronger cooperation between stakeholders	Yes, especially with intermediary employment agencies	C, S, E, G, I, U

Notes: 1. C (company), S (sector organisations and chambers of commerce), E (education & training), G (governments), I (intermediary organisation, public or private), U (trade unions).

14.14 Labourers

Both scenarios (the conversation scenario for the building materials sector and the innovation led growth scenario of the glass and ceramics sector) lead to a decrease of low skilled production jobs as a result of outsourcing processes of these functions to specialised employment agencies.

Table 14.11 presents strategic options for emergent competences related to low skilled labourers. We expect a strong decline in number of jobs with in this job function. That's why no emergent competences were assessed. Instead, current labourers need to be up-skilled/(re)trained with technical and environmental qualifications to the level of production and repair and maintenance workers, or maybe even engineers.

Labourers outside production are likely to be replaced by technology (security/-receptionists) or outsourced to the service sector (cleaning / maintenance).

Table 14.11 Strategic options Labourers

1. What is the maximum volume effect?	Decrease
2. What is the maximum change in skills?	11
3. Do SMEs play a large role?	No
4. Is the sector national/EU/global?	Global (glass+ceramics)/EU (building materials)
5. Is the workforce old?	No
6. Is the workforce low educated?	Yes

Option	**Is this option viable?**	**Actors[1]**
N. Recruiting workers from other sectors	No	-
O. Recruiting workers from other Member States	No	-
P. Recruiting workers from Non-Member States	No	-
Q. Recruiting unemployed with or without re-training	No	-
R. Recruiting young people from the education system	No	-
S. Training and re-training employed workers	Yes, labourers need upskilling in technical and environmental qualifications	C, E, U
T. Changing work organisation	Yes, automation of production processes	C, I
U. Outsourcing and offshoring	Both	C
V. Changing vocational education	Yes, need upskilling to production worker level.	C, S, E
W. Designing and offering new courses	Yes, need upskilling to production worker level.	C, S, E
X. Providing information about emerging skills	-	-
Y. Improve the image of the sector	-	-
Z. Stronger cooperation between stakeholders	-	-
Notes: 1. C (company), S (sector organisations and chambers of commerce), E (education & training), G (governments), I (intermediary organisation, public or private), U (trade unions).		

14.15 Scenario implications, future skills and knowledge needs and possible solutions: summary and main conclusions

Implications of the scenarios in terms of expected volume changes in employment (jobs), future skills and knowledge needs as well as ways to address and solve these needs (strategic choices) have all been analysed so far at the individual job function level. This section serves to summarise (in table 14.12) the main implications and solutions for each of the job functions presented in chapters 12, 13 and 14. It serves as a bridge to the next chapter where we shift from a micro perspective (job functions) to a meso (sector and policy) perspective.

Table 14.12 Summary of job volumes, skills changes, strategic choices and main players in anticipatory action, ranked by scenario				
		Innovation-led growth	**Conservation**	**Resource depletion**
Managers	1. Employment volume change	+	0	0
	2. Skills changes counted	17	6	4
	3. Emerging skills needs	**Entrepreneurship** (trend setting & spotting), **Management** skills (strategic & visionary; Social skills, Problem solving skills, change management), Knowledge	**Knowledge** (legislative, e-skills), Entrepreneurship, Problem-solving	Self-management, Knowledge (legislative & regulatory), Creativity
	4. Most important solutions	Recruiting, Training and retraining, Changing work organisation, Outsourcing and offshoring, Changing vocational education, New courses, Providing information, Improving image, Stronger co-operation	Training and retraining, Recruiting, Changing work organisation, Outsourcing and offshoring, Changing vocational education, New courses, Providing information, Improving image, Stronger co-operation	Training and retraining, Recruiting, Changing work organisation, Improving image, Stronger co-operation
	5. Most important actors	C, E, S, I	C, E, S, I	C, E, S, I
IT professionals	1. Employment volume change	+	0	-
	2. Skills changes counted	15	13	5
	3. Emerging skills needs	**Knowledge** (technical knowledge), Social skills, Management skills, Creativity, Trend setting/spotting,	**Knowledge** (technical knowledge), Social skills, creativity, Management skills, Trend setting/spotting,	Knowledge, Stress & time management, Management skills (project management, process)
	4. Most important solutions	Recruiting young and from other sectors, Training and retraining, Changing work organisation, Outsourcing, Changing vocational education, New courses, Providing information, Improving image, Stronger cooperation	Training and retraining, Recruiting young and from other sectors, Changing work organisation, Outsourcing, Changing vocational education, New courses, Providing information, Improving image, Stronger cooperation	Training and retraining, Recruiting young and from other sectors, Changing work organisation, Outsourcing, Providing information, Improving image, Stronger cooperation
	5. Most important actors	C, E, S, I	C, E, S, I	C, E, S, I
Other professionals	1. Employment volume change	+	+	0
	2. Skills changes counted	13	9	1
	3. Emerging skills needs	**Knowledge** (legislative & regulatory, technical, e-skills), Social skills, Problem solving skills, Self management, trend setting/spotting	**Knowledge** (legislative & regulatory, e-skills), Social skills, Problem solving skills, Planning	Knowledge (e-skills)
	4. Most important solutions	Recruiting young and from other sectors, Training and retraining, Changing work organisation, Offshoring, Changing vocational education, New courses, Providing information, Improving image, Stronger cooperation	Recruiting young and from other sectors, Training and retraining, Changing work organisation, Offshoring, Changing vocational education, New courses, Providing information, Improving image, Stronger cooperation	Recruiting young and from other sectors, Training, Providing information, Improving image, Stronger cooperation
	5. Most important actors	C, E, S, I	C, E, S, I	C, E, S, I

		Innovation-led growth	Conservation	Resource depletion
Engineers and R&D personnel	1. Employment volume change	+	+	-
	2. Skills changes counted	24	13	3
	3. Emerging skills needs	**Knowledge (technical knowledge**, legislative, e-skills), Social skills, Problem solving skills, Management skills (change and project management), Entrepreneurship, Self-management (flexibility, stress)	**Knowledge (technical knowledge**, legislative, e-skills), Management skills (change and project management), Social skills, Problem solving skills, Self-management (flexibility)	**Knowledge (technical knowledge**) Flexibility, Stress & time management
	4. Most important solutions	Recruiting from other countries, Recruiting young, Training and retraining, Changing work organisation, Outsourcing and offshoring, Changing vocational education, New courses, Improving image, stronger cooperation	Recruiting from other countries, Recruiting young, Training and retraining, Changing work organisation, Outsourcing and offshoring, Changing vocational education, New courses, Improving image, stronger cooperation	Training and retraining, Changing work organisation, Improving image
	5. Most important actors	C, E, S, I, G	C, E, S, I, G	C, E, S, I
Accounting & Finance	1. Employment volume change	+	-	-
	2. Skills changes counted	11	10	3
	3. Emerging skills needs	Knowledge **(legislative & regulatory**, e-skills), Social skills, Management skills (process, quality), analytical skills, flexibility, understanding supplier & customers	Knowledge (**legislative & regulatory** knowledge, e-skills), Management skills (process, quality), Social skills, analytical skills, flexibility, understanding supplier & customer	e-skills, flexibility, process management
	4. Most important solutions	Recruiting, Training and retraining, Outsourcing, Changing vocational education, New courses, Providing information, Stronger cooperation	Training and retraining, Recruiting, Outsourcing, Changing vocational education, New courses, Providing information, Stronger cooperation	Training and retraining, Changing vocational education, New courses
	5. Most important actors	C, E, S, I	C, E, S, I	C, E, S, I
Sales & Marketing	1. Employment volume change	+	0	0
	2. Skills changes counted	21	12	5
	3. Emerging skills needs	Entrepreneurship (**business development, marketing skills, trend setting / spotting**), Social skills, Management skills, Knowledge, flexibility, analytical skills, creativity	Entrepreneurship (**business development, marketing skills**), Social skills, Management skills, Knowledge, analytical skills, flexibility	Entrepreneurship (business development, marketing), e-skills, flexibility, stress management
	4. Most important solutions	Recruiting young people, Training and retraining, Outsourcing, New courses, Providing information, Improving image, Stronger cooperation	Recruiting young people, Training and retraining, Outsourcing, New courses, Providing information, Improving image, Stronger cooperation	Recruiting young people, Training and retraining, New courses, Providing information, Improving image, Stronger cooperation
	5. Most important actors	C, E, S, I	C, E, S, I	C, E, S, I

		Innovation-led growth	Conservation	Resource depletion
Administrative support staff	1. Employment volume change	0	-	-
	2. Skills changes counted	11	9	3
	3. Emerging skills needs	Self management (all), Social skills, understanding suppliers & customers, entrepreneurship, e-skills	Self management (all), Social skills, understanding suppliers & customers, entrepreneurship, e-skills	Self-management (planning, stress management, flexibility), team working, communication, e-skills
	4. Most important solutions	Recruiting young people, Training and retraining, Changing work organisation, Outsourcing, Stronger cooperation	Recruiting young people, Training and retraining, Changing work organisation, Outsourcing, Stronger cooperation	Recruiting young people, Training and retraining, Outsourcing, Stronger cooperation
	5. Most important actors	C, E, I	C, E, I	
Truck drivers	1. Employment volume change	+	-	-
	2. Skills changes counted	9	9	5
	3. Emerging skills needs	Knowledge, Self management, Social skills, Problem Solving	Knowledge, Self management, Social skills, Problem Solving	Self management, Social skills
	4. Most important solutions	Recruiting from other Member States, Outsourcing, Changing vocational education, New courses	Recruiting from other Member States, Outsourcing, Changing vocational education, New courses	Recruiting from other Member States, Outsourcing
	5. Most important actors	C, E, S	C, E, S	
Skilled production workers	1. Employment volume change	+/-	-/+	-
	2. Skills changes counted	14	11	5
	3. Emerging skills needs	Knowledge, Social skills, Self management, Problem solving skills, Quality management	Knowledge, Social skills, Self management, analytical skills, creativity	Knowledge, Self management
	4. Most important solutions	Recruiting young people, Training and retraining, Changing work organisation, Offshoring, Changing vocational education, New courses, Providing information, Improving image, Stronger cooperation	Recruiting young people, Training and retraining, Changing work organisation, Offshoring, Changing vocational education, New courses, Providing information, Improving image, Stronger cooperation	Recruiting young people, Training and retraining, Changing vocational education, New courses, Providing information, Improving image, Stronger cooperation
	5. Most important actors	C, E, S, I	C,E, S, I	
Plant and machinery repair and maintenance workers	1. Employment volume change	0	+	-
	2. Skills changes counted	18	12	5
	3. Emerging skills needs	**Knowledge** (legislative & regulatory, **technical knowledge**), Self management, Social skills, Problem solving skills, Management skills	**Knowledge** (legislative & regulatory, **technical knowledge**), Self management, Social skills, Management skills, Problem solving skills	Self Management (flexibility, stress management), Knowledge (e-skills, technical), Creativity,
	4. Most important solutions	Recruiting young people, Training and retraining, Outsourcing, Changing vocational education, New courses, Providing information, Improving image, Stronger cooperation	Recruiting young people, Training and retraining, Outsourcing, Changing vocational education, New courses, Providing information, Improving image, Stronger cooperation	Recruiting young people, Training and retraining, Outsourcing, Changing vocational education, New courses, Providing information, Improving image, Stronger cooperation
	5. Most important actors	C, E, S, I	C, E, S, I	C, E, S, I

		Innovation-led growth	Conservation	Resource depletion
Labourers	1. Employment volume change	-	-	-
	2. Skills changes counted	11	10	4
	3. Emerging skills needs	Social skills, Knowledge, Self management, Problem solving skills, quality management	Social skills, Knowledge, Self management, multi-skilling, quality management	Social skills, Self management
	4. Most important solutions	Training and retraining, Changing work organisation, Outsourcing and offshoring, Changing vocational education, New courses	Training and retraining, Changing work organisation, Outsourcing and offshoring, Changing vocational education, New courses	Training, up-skilling
	5. Most important actors	C, E, S, I	C, E, S, I	C, E, S, I

15 Conclusions and recommendations for education and training

15.1 Introduction

This chapter presents the main conclusions and recommendations for education and training; chapter 16 presents the main other conclusions and recommendations. Whereas the earlier chapters very much take a micro perspective by focusing on job functions in terms of expected volume changes, skills and knowledge needs and ways to address and solve these needs (strategic choices), chapter 15 takes a *meso* or *sector* perspective. It addresses a number of issues, part of which coming already to the fore in earlier chapters, and part being 'new' issues although much related to those already raised. The conclusions and recommendations are mostly based on the results of the preceding chapters; they were discussed during the final workshop with social partners, the industry and other experts.

The recommendations contained in this chapter should not be seen as fully exhaustive. They rather form the basis for further discussion and elaboration at various decision-making levels, ranging from the European Union and the Member State to the regional and local level. Industry itself – firms – have an important role to play, as do education and training institutes, social partners and the government (EU, national, regional and local). In most cases action should be taken jointly, by involving various actors, sometimes even at different levels. Collaboration and co-operation as buzzwords in today's economy are easily coined. Making collaboration work in practice is, however, a challenge which requires mutual understanding, compromise and perseverance.

15.2 Conclusions and recommendations for education and training

1) Adapt and modernise vocational education and training (VET) and general education systems, but do this nationally rather than at the EU level.

Both vocational education and training (VET) systems and the general education systems (primary, secondary and tertiary education) differ considerably between Member States, in terms general set-up, organisation and implementation (see Box 6). While a discussion about which are the most adequate models and/or best practices is useful, the current variety in VET and general education systems in Europe makes it very difficult to come up with specific conclusions or recommendations about training and education needs and requirements for the non-metallic materials sector from an EU-wide perspective. Most conclusions and recommendations should be based on the particularities of the existing education systems in the Member States, or even regions. This obviously is beyond the scope of this study. Some general observations can, however, be made. As a general trend most Member States at all levels of education tend to focus more than in the past on 'teaching' soft skills, by integrating soft-skills related lessons in existing curricula. One also observes a counterdevelopment in that in some Member States there is again a call for conventional knowledge and the teaching of 'harder' skills, as the attention for soft skills would go at their expense. This holds both for secondary education (relating to essential knowledge of foreign languages, mathematics, physics and chemistry) as well as university education (too broad curricula). Inter/multidisciplinary training and training tools are still lacking in many universities and high schools which makes that graduates enter less prepared than desirable on the labour

market. One important prerequisite is the necessity to avail of *professional teachers* who have knowledge on the current state-of-the-art and developments in the non-metallic materials

Box 6. Vocational education and training – rich variety between Member States

A number of different systems in Vocational Education and Training (VET) as well as Initial and Continuing Vocational Education and Training (IVET and CVET) can be observed throughout the European Union. Various characteristics of these systems have to be taken into consideration when discussing possible specific implications for education and training. Existing VET-systems can be grouped into three main categories ('ideal types'), (i) liberal, (ii) state-controlled and (iii) corporatist VET-systems, each having a different underlying rationale and distinguishing characteristics. Key in this distinction are those who decide about the structure and content of VET: business itself, the state or the state together with social partners (see Table below). The three VET-systems of Germany, France and the United Kingdom are of special importance as they can be taken as representative for each of the three 'ideal type' categorisations. They are evidence of the rich variations in existing VET systems and their implementation in Europe. The enterprise-based training system of Germany (the 'Dual System') is implemented by the social partners and the state. Next to this prevailing system other forms of VET exist. In France, a school-based training system is established and implemented by the state. Even though the full-time school-based training system competes to some extent with an upcoming apprenticeship training system, it is still the dominant form of vocational training in France. The system implemented in the UK, the national vocational qualification, is regulated and driven by market forces in several important segments. Although national vocational qualifications (NVQ) and general national vocational qualifications (GNVQ) are regulated at national level, the implementation of training is not yet regulated at national level. Commercial certification systems are still competing with national ones. Work-based, as well as full-time school-based training can be found. Special training schemes for unemployed, such as school-based schemes for unemployed youths or work social enterprises for long-term unemployed, are present in several European Member States. Besides these 'ideal types' several mixed forms in Europe exist. In Spain, for example, one finds more informal forms of VET and in Central and East European countries the trend can be detected, that VET moves from a state centred model to a stronger corporatist model, while also business driven approaches exist in some sectors.

Table to Box 6. Three 'ideal-type' VET-models (elaborated from Clematide, 2005)

	A. Liberal	**B. State-controlled**	**C. Corporatist**
Decision maker	Business (and individuals)	State	State and social partner organisations
Rationale	Liberalistic competitive	Centralistic state-centred	Corporative – social consensus
Programmes	Business and individual	Education and citizen	Occupation
Content	Needs of business and individual, utility oriented, short term and specific	Politically determined, general knowledge, course-oriented, academic	Determined by social partners, occupation centred, traditions
Labour markets VET relates to	Internal (business) labour markets	Occupational and internal labour markets	Occupational labour markets
Strengths	Flexible, cheap for the state, close to the needs of production	Strong linkage to the education system, no lack of training places	Broad vocational educations with status equal to general education
Weaknesses	Under-investment in training and education	Weak linkage to the labour market	Inertia in the institutions
Representatives	United Kingdom, Ireland	France	Germany, Austria, Denmark
Trends	Stronger state involvement in certification and quality	"Dual system" emerging and stronger orientation on business needs	Internal labour markets Marketing of VET

sector and are able to transfer their enthusiasm to students. Another instrument to bridge the gap between theory and practice is to incorporate researchers more in the primary process at firm level, by stimulating mobility and introducing exchange programmes. The different VET systems in Europe all have their own merits. It would make no sense to try to standardise VET throughout Europe. Especially in the new Member States, more focus and assistance is required to further fine-tune the existing VET systems to new and emerging needs (see further below).

Improving the adaptability of the national education and training systems is needed to better address skill shortages and gaps due to medium and longer-term shifts in skills and knowledge demand. Institutionalising contacts between educational authorities, trade unions and firms representatives on the content of curricula, apprenticeship (or dual education) systems in vocational education could help address this (see further point 3).

2) Strengthen scientific and technical profiles in education

Scientific and technical profiles in education should be strengthened at all levels. This specifically applies to basic education in mathematics, physics and chemistry[20].

3) Re-evaluate and revalue the position of apprenticeships in the training and education system

Apprenticeships have recently seen a revival in interest. Many of the existing apprenticeships in Central and Eastern Europe appear to have ceased in existence in the post-Communist era. A re-evaluation and revaluation of the apprenticeship system and possibly a wider reintroduction could serve to further build a competitive skills base.

4) Improve the provision of information on future skills and training needs to both students and trainers

The information gap between current and future education and training needs on the one hand, and what education and training have to offer and plan for the future (i.e. the education and training supply) on the other is considerable. Consequently, a mismatch between actual VET supply and demand in quality as well as - to a lesser extent - in quantity is observed for some occupational functions. Training providers often do not meet vital training needs and/or do not sufficiently respond to emergent training needs; this especially holds for vocational training systems.

An important option for all actors is to distribute and produce elaborated and easy-to-grasp scenarios on the prospects of different skills – related to job profiles - in the non-metallic materials industries. This type of information would give students better opportunities to decide which skills they would need and prefer to learn. Improvements in the provision of information on future labour market prospects, in terms of emerging job functions, skills and knowledge needs and hence increasing transparency would facilitate a smoother adjustment and enable better anticipation to emerging skills and knowledge needs. There is another

[20] Explicitly and unanimously addressed by all stakeholders at the final workshop.

reason why improving the flow of information would be beneficial; lack of transparency in the training market can easily lead to underinvestment or 'wrong' investment in training.

Better information on the content and quality of training programmes, certification and standards may enhance transparency. Promoting transparency is obviously a task for the central government and local authorities, possibly with help of other stakeholders (e.g. intermediairies and the industry at large). However, predicting the future situation on the labour market is a difficult task. With the exception of particular occupations where demand is to a large extent driven by demographic factors, such as engineering and teaching, a lot of (inherent) uncertainty about the future will remain.

The information on and the possibilities for combatting skills and knowledge shortages in the short, medium and longer term is different for large companies and SMEs, not to mention micro-enterprises. In the construction materials industry in the EU-15, a substantial part majority of the workforce is employed by relatively few very large companies. Large companies have a strong(er) position to drive training and people development to support business performance. The building products industry in the UK has for instance successfully developed distance-learning offerings to support technical qualifications, e.g., the Technical Certificate in clay Building Products, as a response to an overall decline in technical courses delivered by colleges. SMEs often have difficulties in financing CVET and in finding suitable solutions to training leaves of their staff. Consequently, a major implication for education and training is the establishment of improved information systems on current and emergent skills needs and job opportunities. Information systems on the sectoral level as well as on the regional, the national and the European level will help reducing information asymmetries and hence better address skills gaps. Facilitating students to enter the labour market and to find a suitable occupation is just as much important as assisting employees to find new job opportunities based on their existing skills or guiding them to find the appropriate vocational training course.

5) Closer collaboration between stakeholders needed to tackle emergent skills and knowledge gaps

Close collaboration between all relevant stakeholders, such as companies, education and training organisations, social partner organisations, research institutions and public authorities, can actively support the needed increase in transparency and minimizing information deficits on current and emergent skills and knowledge needs. Closer and more pro-active collaboration is an option to facilitate smooth adjustment in a changing environment. Examples one could think of in this context are institutionalised contacts between educational authorities and trade unions and firm representatives on the content of curricula, apprenticeship (or dual education) systems in vocational education, removing barriers to entry for new (private) suppliers of education, and grants to stimulate enrolment in particular types of education.

There is growing concern that the non-metallic materials sector will face a shortage of skilled professionals, particularly university graduates. The same goes for supply industries like mining and mineral engineering. In some Member States, this issue is being addressed via mixed working groups (European Commission, 2006; ditto, 2007a). The Federation of European Mineral Programmes (FEMP) is an example of nine universities and 25 larger companies from different Member States trying to address this challenge. They pool their resources and jointly offer high-quality programmes. Additionally, industry needs current

personnel to be sufficiently skilled in order to efficiently and productively apply new technologies, and to comply with high environmental and health and safety standards, specifically in the new Member States. The primary responsibility of attracting students to programmes lies with universities and industry. In this regard, there is a need for more interaction between different actors, including government, for more networking and knowledge transfer. The experience with such activities in Germany and Spain, among others, could provide interesting insights into how this could be achieved. Also, benefits could be reaped from closer pan-European co-ordination. An EU-wide initiative similar to the German Society for Mining, Metallurgy, Resource and Environmental Technology's (GDMB) committee on mining education could prove to be a useful way forward.

Collaboration is an effective instrument to stimulate that changes in VET are better discussed and implemented. A stronger linkage between industry and education and training is recommended in state driven full-time school-based VET-Systems (Koch and Reuling, 1998). In the new Member States in particular, co-operations are essential to improve the practical orientation in VET (Skjølstrup and Mayen, 2007). The 'Sector Skills Councils'[21] in the United Kingdom and the 'FreQueNz' research network[22] are examples of this kind of co-operation and are described below.

The 'Sector Skills Councils' in UK are funded by the Department for Innovation, Universities and Skills and are part of the government's skills strategy for the 21st century. The councils ensure that individuals gain the skills they need so that persons with fitting skills are available. Sector skills strategies are defined for each sector based on the analysis of present and future skills needs[23].

FreQueNz is a research network located in Germany and funded by public means. The network comprises scientific institutes, education and training organisations, social partner organisations, companies and public authorities and contributes to early identification of qualification needs. This network has conducted a number of evaluative research projects on human and ICT resources, staff qualifications, tests, career guidance for adults, computerised career guidance programmes, and beneficiaries of guidance services.
The global regionalization means that firms need to cluster or join networks in order to create joint educational and training programmes.

6) Improve and enhance the possibilities to engage in life-long learning

Whereas the number of employees in especially the glass and ceramics has decreased as a result of further capital intensity and automation, a well developed skills base is essential in being able to compete with other parts of the world. With production shifting to more flexible and specialised forms of production, knowledged-based, creative and linked to automation, with just-in-time delivery and improved service orientation becoming even more important assets, this requires employees to adapt and adjust their skills and knowledge base. VET systems should be enhanced to facilitate the option for people to continuously up-skill as part of life-long learning (LLL). Traditionally the VET system plays a key role for people to move up the social ladder, and especially in for 'late developers' that in the first instance did not reach tertiary education.

[21] www.sscalliance.org
[22] www.frequenz.net
[23] Further information http://www.ssda.org.uk

Efforts to promote life-long learning include targeted training programmes, modularisation, forms of blended learning (e.g. IT-based), the design and funding of new education and training programmes, investment in the mobility of workers, better recognition of qualifications across Europe, for instance by introducing experience certificates, as well as efforts by the sector to further improve the image of the sector, especially among young people. Each of these measures is described more in full in the next points.

7) Further enhance the flexibility of vocational training to address emerging training needs by modularisation, flexible and blended learning and Experience Certificates

Strengthening the information basis on skill demands and supply of training as well as career possibilities is essential; they are the basis for enhanced flexibility and adaptability of continuing vocational education and training. Flexibility refers to the capability of the VET System to adapt effectively to new training needs in terms of quality and quantity. A flexible VET-System is required in particular in circumstances in which profound changes take place and job functions and occupational profiles need to be modified quickly. In order to achieve more flexibility and to respond in-time with altering training contents a *modularisation* of education and training is recommended. Even if problems will occur in the modularisation of training in some IVET-Systems modular systems facilitate the building up of competences and ease the interaction between IVET and CVET Systems. Flexibility is also required for different forms of education and training. Flexible forms of *blended learning* contribute to enhanced participation of, in particular, SME employees in continuing vocational training (SMEs often face difficulties in releasing workers for training).

In principle, blended learning combines face-to-face and group-based learning with up-to-date offline media and online e-learning forms, as for example digital learning modules on websites, video conferences, joint learning applications, newsgroups and blogs for interactive online learning. This is not only a possibility to reduce costs of further training and enhance flexibility to combine work with training, but it also has positive effects on skills which will be needed in the future. Because large parts of such training are self-directed and informal, the learner has to build up several competences, like self reflection, self motivation, strength of purposes and an effective information processing.

Another aspect to enhance flexibility is to further streamline Vocational Qualifications in the EU, by using *Experience Certificates*. The two main non-metallic materials sub-sectors, construction materials, and the glass and ceramics industry, are in need of soft skills, such as communication skills, project management skills and e-skills. These are seldomly mentioned in diplomas or part of regular education programmes, but rather learnt on the job. When recruiting workers from other countries or from other sectors, it is almost impossible to find out whether a recruit is skilled in these areas or not. Certificates would reduce related barriers to recruiting, and would therefore be of help, particularly in the ‘Innovation-led growth’ scenario.

8) Actively promote multi-skilling and provide adequate training modules

Multi-skilling describes the process of gaining knowledge from different disciplines. Multi-skilling is increasingly required in a number of occupational functions. For engineers, for instance, nowadays not only up-to-date technical skills and knowledge are essential, but also

management skills. Managerial courses should therefore be incorporated into engineering curricula. To further pursue multi-skilling, also in other job functions, and to be able to offer applicable courses for the industry, not only co-operations between the training sector and companies in the non-metallic materials sector are needed, but also between different training providers. In several countries stable co-operations between the industry and universities, colleges and other private training providers already exist, but these could be further enhanced and strengthened. Their main purpose should be to provide combined and interlinked training modules for the sector.

9) Design and provide special courses dedicated to specific sector requirements

For some job functions special courses are needed. It is necessary to have a better balance between what is offered in the educational system and what is needed in the sector. To give an example: the *glass and ceramics producers* in the European Union are world leaders in creativity, design, and technology – but without the right conditions in place to manufacture and sell their products on world markets, their long-term sustainable competitiveness is under threat. In the short term, relocation to places outside the EU where social, energy, and environment costs are lower, and which are not carbon constrained, is a real threat (European Commission, 2007b). Therefore, it is a special challenge for these energy-intensive industries to develop knowledge and training on more sustainable approaches. Firms that are able to improve the 'energy-saving' and environmental friendly skills of the workforce fast, have a competitive advantage. Education and training institutions can exploit this situation to provide dedicated courses.

10) Supply special courses for older workers and arrange for provisions to make them stay

As the workforce in several occupational functions is ageing, education and training institutions should take this development into account in the design of training measures to develop specific courses, for instance to enable workers to better adjust to changing work environments as a result of automation, or to shift to relatively lighter tasks and activities within the organisation, better fit to their physical and mental abilities.

There is good reason in trying to keep and 'save' the older employees for the industry. One of the reasons is that the supply of skilled younger workers is limited and faces strong competition from other sectors. Another reason is that older workers often dispose of specific technical and craft-related abilities involving a lot of tacit knowledge. Keeping the skills base in the industry intact means that ways have to be found in which this tacit knowledge can be transferred to the younger workforce.

In designing these courses, it should be borne in mind that older students generally have more problems with theory-based, upfront teaching only focused on examinations. For older workers this kind of training is less effective, as it is not exploiting practical experience in the learning process.

There might also be reason for Member States to arrange for special provisions to keep older employees at work and to (re)train them. These could relate to specific schooling incentives but could also apply to tax exemptions/arrangements and tailor-made pension provisions. The current incentives for elderly workers to train and study are relatively low in most Member

States, firstly because their fall back positions in terms of early retirement schemes and unemployment benefits are relatively favourable in most EU countries. Secondly, the private returns of training of older workers to firms and employees may be lower due to the shorter recovery period of the training investments. Low participation of older workers may also signal relatively low learning abilities. All this should be kept in mind when trying to increase the participation rate of older workers. Box 7 provides more information about the participation of different age groups in training.

Box 7. Differences in training participation across countries, firms, employees and ages

Average participation in training varies largely across the Member States of the EU. The average training participation of workers between 25-64 years old in a year ranges from 60 per cent in Sweden to about 15 per cent in some new Member States (cf. Bassanini et al., 2005). In addition, training participation differs largely across different types of workers. It follows rather systematically that participation of younger workers, better skilled workers, workers with fixed contracts and workers in larger firms is above average, whereas participation of lower skilled and older workers, workers with flexible contracts, and workers in small and medium sized enterprises (SMEs) is lower than average (cf. Brunello, 2006; Bassanini et al., 2005; Ok en Tergeist, 2003).
Employers appear to finance the largest share of training costs. On average, the entire cost of about 75 per cent of the training courses is directly paid by employers. Employers' training investments amount to 2.3 per cent of total labour costs for the EU-15 on average, ranging from 0.9 per cent in Greece to 3.0 per cent in Denmark.

11) Provide career guidance for labour market entrants

Regularly, persons equipped with required skills and qualifications are available, but do not apply for vacancies due to the lack of information on labour market possibilities. Systems for the recognition of prior learning (RPL) support the determination to what extent people possess necessary competences for a new job. The integration of RPL in career guidance and targeted training bridges the gap of hidden competences especially for mature workers. Some Member States included this in their system. In Portugal, for instance, a National System of Recognising, Validating and Certifying Prior Learning (RVCC) is implemented through a network of centres. Adults, whether employed or unemployed, are offered a three-tiered service, namely information, counselling and complementary training, including the accreditation of competencies (OECD/European Commission, 2004, p. 31). Career guidance can be supported by user friendly online-tools, also for self guidance. An extraordinary example in this respect is the Polish multi-dimensional career information system called 'Counsellor 2000' (ibid, p. 44) in which information about educational and training pathways, and the relevant occupations they lead to, is linked to the personal profile of the client using an online-system.

12) Increase international and intersectoral acknowledgement of qualification certificates

For some job functions international and sector mobility is an option to meet future skill needs. To increase the viability of this option, improving the acknowledgement of certificates between countries is important. This is also the case for in-house training as several of these training measures are not certified. This prevents a greater mobility of the workforce and

hinders the matching of skill demand and supply because of a lack of skills transparency. Educational institutions that are able to provide broadly accepted certificates, increase their value added for students. However, they need often governments to build effective acknowledgement systems.

An example from the UK are Sector Skills Agreements (SSAs) that aim to fundamentally alter the way skills are demanded, delivered and developed throughout the UK[24]. They map out exactly what skills employers need their workforce to have and how these skills will be supplied – both now and in the future. They are about getting the right people with the right skills in the right place at the right time. SSAs are facilitated by the Sector Skills Councils but are subscribed to by everyone who supplies, funds and plans education and training. They are created by a process which involves a number of partners including employers, trade associations and employer bodies, and organisations that supply and fund education and training (including further and higher education).

13) Handicraft – artisanal production of ceramics and glass in danger

The ceramics and glass sectors still accounts for a substantial number of artisanal producers of hand-made glass and ceramics. These micro-enterprises specialised in handicraft, of which there are many but mostly unknown, are mainly based in France, Italy, Germany, Slovakia, the Czech Republic and Poland. A serious concern as to the future of these handicraft glass and ceramics sub-sectors is that vocational schools that educate the workforce in this market segment has virtually disappeared.

14) Wanted: e-skills, intercultural, language, creative, health & safety, and 'green' skills

Up-to-date *e-skills*, not only in regard of further automation in the sector, but also to the potential of e-commerce (B2B, B2C) and the Internet in attracting new customers and finding new markets, are vital to the sector. Up-to-date e-skills are best guaranteed by recruiting young people with the right skills. The younger generations people are also better used to work with IT. Even so, adequate attention for IT-skills in the form of special training might apply, for instance for older workers operating in a more automated environment.

Cross-national consolidation and internationalisation call for improvements in *language and multicultural skills*. As young people tend to possess more intercultural and language skills as they grew up in a more mixed society/ school environment, recruiting young people through vocational training systems is an important strategic option, also for this reason. As image and attracting young employees go hand in hand, the sector needs to stimulate the interest in schools in technical and science related subjects for people to obtain the necessary technical understanding for working in a science based industry.

Like in other industries, the production of higher value added requires a *firmer knowledge base and creativity*. It also requires *more interdisciplinary and team work*, and hence a stronger need for soft skills, such as team working, communication skills and project management skills. Such skills are more difficult to fulfil in formal learning trajectories and are usually learnt on the job; however, they are seldomly mentioned in diplomas or part of

[24] Further information from http://www.ssda.org.uk

regular education programmes. One way to facilitate and further improve recruitment of people with adequate soft skills is to include certain soft skills as part of Experience Certificates. Training in soft skills where possible should also receive more attention in formal education.

With *health and safety* becoming more important, in the workplace (working conditions) and vis-à-vis customers, the need to up-skill general skills and knowledge on health and safety needs to be stepped across job functions.

Firms that are able to improve the *'energy-saving'* and *'green' skills* of the workforce fast, have a competitive advantage. Education and training institutions can exploit this situation to provide dedicated courses. Training courses preparing workers for new more environmental friendly technologies are needed to keep technical skills up-to-date. To reflect different learning styles these should be adapted for younger and older workers.

16 Main other conclusions and recommendations

16.1 Introduction

This report concludes with a number of 'other' (i.e. going beyond education and training) conclusions and recommendations based on the results and insights gained during the course of this study. They include the results of an intensive two day workshop with various stakeholders and the European Commission during which the draft final results, including preliminary recommendations, were discussed. The conclusions and recommendations apply to the sector at large (including individual firms, sector organisations, chambers of commerce, social partners), intermediary organisations, education and training institutes, as well as policy-makers (EU, Member States, regions).

The recommendations point into viable and useful directions rather than that they represent ready-made proposals for change. Reflection and debate, and finding creative answers to plausible futures in skills and jobs is, in the absence of a crystal ball, the way forward. The bandwidth between the expected developments in the most extreme scenarios is indicative for the degree of uncertainty by which the future should be approached. Solutions to future skills needs should therefore be flexible, smart and encompassing enough to address the differences between the various scenario outcomes, not knowing what real future will eventually emerge.

16.2 Main other recommendations

1) Collaborate with all relevant stakeholders and intensify co-operation: Partnerships for Innovation and Job creation and Social Dialogue

The first recommendation to meet existing and emergent skills and knowledge needs for the non-metallic materials sector is to support intensified co-operation between all relevant stakeholders in the sector. The challenge to overcome sectoral skill gaps and shortages can be met if industry, research, training providers, social partners and public authorities act in concert. Employers' organisations and trade unions in most countries are capable, in co-

operation with training providers and educational institutes, to commonly and better address future skills and knowledge needs, and also set up funds for the training of employees. Collaboration is required to meet the skills and knowledge needs and support the development of sectoral learning strategies, but also to foster sustainable development, exchange best practices and promote R&D innovation, for instance by establishing *partnerships for innovation and job creation*. Examples of the latter are the Initiative for Sustainability in the German cements industry, and the European Technology Platform (ETP) on Sustainable Mineral Resources (see section 3.7). The broader platform of the *Social Dialogue*, both at Member State and European level, can serve to further discuss priorities and feasible actions. The Social Dialogue Sectoral Committees also have an important role in proactively disseminating the importance of addressing future skills and knowledge needs.

2) Improve the image and attractiveness of the sector – to the young and society at large

To improve the image of the sector to young employees, the non-metallic materials sector should use its image as a '*dynamic innovation podium*' in its recruitment activities. Parts of the sector, most importantly the construction materials sector, are still seen as heavy and dirty industries, even if working conditions have improved, automation has found its way in and new innovative segments have emerged. Ceramics is still perceived as volatile sector which deters new people from working in the sector. The non-metallic materials sector should actively be brought to schools in order to reach young students with affinity to work in construction materials and in glass and ceramics. This should focus on vocational and higher education (workshops, apprenticeships etc.). Next to technical universities the focus should be on managerial/business, sales and marketing and accounting studies. Awareness campaigns and reaching out to schools (e.g. the European Minerals Day) have already been taken up in some parts of the sector, for instance with a CD ROM Mineral Zone as learning resource in various languages by IMA as from 2005, which is being developed also in a web version to make it more easily available to schools and other interested parties. Further media, communication and awareness campaigns should be taken up with strength.

A more environmentally friendly image could help to attract students to the non-metallic materials sector. Not only the energy-intensity but the overall environmental performance of the sector needs to be improved and effectively communicated to potential new recruits. Environmental performance in transport of construction, glass and ceramics over land needs to be actively addressed. Moreover, sales and marketing should help to show the public an environmental friendly attitude of the sector. This will counterbalance the decline in marketing jobs as a result of the trend of offshoring of (polluting) production plants.

Branding and design of products and development of cleaner products can be additional assets in further improving the image of the sector and to build a workforce that has not only high-skilled technical capabilities, but is increasingly creative, knowledge-intensive and oriented towards high-value segments of the market. This holds for glass and ceramics, but also for construction materials. Improving the image is a challenge that is shared with a number of other sectors demanding a technically skilled labour force. Image improvement is a complex task in which various stakeholders have a role to play.

3) Actively pursue the development of new high-tech materials and innovative applications through up-skilling, R&D, creativity and design, knowledge and innovation transfer and promotion of entrepreneurship

New materials and innovative applications can offer promising new markets for the glass, ceramics and construction materials sub-sectors. The application of nanotechnologies and other new technological developments, such as in glass fibres and fibre optics (e.g. car applications), functional materials including self-cleaning and therapeutic ceramic particles, fire-retarding materials, coatings for carpets, automotive and wallpaper and many more product developments offer interesting niches. With these new products and markets go new skills and knowledge. The future focus should not be on big volumes and mass production only, but also on small high-value segments. In order to be able to successful in developing "new products/new markets" the sub-sectors' profiles need to move up towards a more high-tech profile. To be able to grab new attractive niche markets where price competition is less important and profit margins are typically higher, a rapid transformation is needed. This not only requires a further up-skilling of the current skills base, and for instance attracting more creativity and design skills in certain sub-sectors (fine glass and ceramics), but also knowledge and innovation transfer schemes from R&D institutes to the industry and more, and more targeted, R&D. Strengthening of current and R&D and innovation programmes is needed, including a better prioritisation of R&D in FP7 and further support under the CIP programme supporting innovation in SMEs. Especially small companies have difficulties in innovating. Good examples of innovative medium-sized companies exist, however. R&D on new types of cement and concrete for special applications and purposes (e.g. for the construction works of the German fast speed train) have proven successful in the past. Despite the fact such research is not always regarded as very 'sexy', new pathways should be explored. The European Technology Platform (ETP) on Sustainable Mineral Resources under FP7 and the Seventh Framework Programme (FP7) itself so far appear not very tailored to specific questions and needs, however. One of the addicted problems is that a *real* dialogue on R&D issues so far has been missing. One idea that is supported by the sector is the establishment of test plants to further facilitate the commercialisation of new products and production processes. Co-financing by the EU would be highly welcome. It is recognised that defense industry is an important source of innovation, and has yielded a number of new applications for the sector.

4) Actively address and implement the 10 actions foreseen in the *Raw Materials Initiative*

The Raw Materials Initiative which is the result of discussions of a European Commission Inter-Service Group is regarded a necessary and vital step towards a sustainable and competitive future of the non-metallic materials industry. The Initiative, amongst others, addresses the following actions (see also Annex III):

- Improvements in the regulatory framework related to access to land
- Increasing resource efficiency and fostering substitution of raw materials
- Promote recycling and facilitate the use of secondary raw materials
- Encourage better networking between national geological surveys with the aim of increasing the EU's knowledge base
- Promote skills and research
    - Promote skills through effective partnerships between universities, geological surveys and industry and promote more awareness
    - Promote focussed research on innovative exploration and extraction technologies, recycling, materials substitution and resource efficiency.

5) Improve energy efficiency and environmental performance, also in transport

Apart from measures to further sustainability and reduce energy use in production – stimulated by IPPC and ETS and by rationalisation and cost reduction due to competition – are important. At the same time, it should be realised that transport by road must be discussed from an environmental perspective and alternatives be encouraged. The sector must actively search for transport alternatives, e.g. by train. Governments have an important role to play in transport, not only in modern 'polluter pay-as-you go' systems of road use, but also in design of infrastructure at large (design of cities, alternative transport modes (inward shipping, rail)). The development and handling of CO2 emissions under ETS should be observed with care, as it may undermine future EU competitiveness, lead to carbon leakage and have undesired consequences, including closures of European plants, offshoring and imports that are more pollutant than the current EU products.

6) Diversify personnel and take positive action

Another general recommendation is *to diversify personnel* in all job functions in the sector. This goal can be reached by broadening the scope of recruitment, to include female workers and other groups. Personnel diversification makes the sector more appealing to groups the sector currently underrepresented. The non-metallic materials sector has become a mainly older, 'white male' sector. There will especially be a need for engineers and managers in the future. In the 'Conservation' scenario of the building materials sector the restructuring of operation and plant modernisation in the frame of environmental improvement is the source of the growth of the demand for engineers and managers. In glass and ceramics the increase will go together with a focus on high-end and specialty products, which make a closer cooperation with the customers more necessary. In formulating a recruitment strategy aimed at pulling in new engineers and managers, firms should broaden their recruitment horizon and aim at female management potential. The non-metallic materials sector should not remain a 'white males' only sector. Recruitment of females through well developed technical traineeships (or courses) is an option. These training packages should also be made available (tailored) for older workers to retrain them

Personnel diversification not only can solve staffing problems but it could also enable companies to develop business in new markets, to attract new client groups or to explore new markets in other countries. Recruitment from different ethnic and cultural groups helps to build better intercultural and communication skills needed in almost all job functions, especially in the 'Innovation-led growth' scenario.

7) Invest strongly in human capital

In order to meet the modernise the skills and knowledge base in the non-metallic materials sector and prepare for future needs, enhanced *investment in human capital* is required. Cost sharing mechanisms between actors, such as public authorities, companies – in particular SMEs and micro-enterprises - and individuals, need to be developed, lifelong learning promoted, and training and education systems and ways of learning improved. To learn must become more attractive to all, promoted and supported by tax incentives and other means. A change of attitude is also needed to integrate learning in all phases of life, and to apply a lifecycle approach to work.

Annex I. Contributors to this study

This report appears in a series of 11 sector reports on the future jobs and skills commissioned by the European Commission and executed by a core consortium of TNO (Delft/Leiden, the Netherlands), SEOR Erasmus University (Rotterdam, the Netherlands) and ZSI - Zentrum für Soziale Innovation (Vienna, Austria). The consortium was led by Dr F.A. van der Zee (TNO Innovation Policy group and TNO Innovation & Environment).

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Annex III. Overview of main elements of the Raw Materials Initiative

Overview based on a European Commission (2008) presentation entitled "Meeting our Critical Needs for Growth and Jobs in Europe". 2008 European Minerals Forum, Brussels, 26 November 2008

Define a list of critical raw materials

- to identify – in close cooperation with Member States and stakeholders – a methodology and list of potentially critical raw materials

Improve the regulatory framework related to access to land

- Promote the exchange of best practices in the area of land use planning and administrative conditions for exploration and extraction
- Develop guidelines on reconciling extraction activities in or near Natura 2000 areas with environmental protection

Increase resource efficiency and foster substitution of raw materials

- Give impetus to resource efficiency and eco-innovative production processes in the context of the Action Plan on Sustainable Consumption and production and Sustainable Industrial Policy.
- Promote research projects that focus on resource-efficient products and production under FP7.
- Exchange information with the International Panel for Sustainable Resource Management.

Promote recycling and facilitate the use of secondary raw materials

- Promote sound implementation of Waste Directives:ensure sound and harmonised enforcement of the Waste Shipment Regulation; release information on illegal shipments.
- Encourage recycling markets through the following measures: legislation, standards and labelling; public procurement; knowledge sharing and international action (2008-2011 Action Plan for the Lead Market Initiative on Recycling).

Encourage better networking between national geological surveys with the aim of increasing the EU's knowledge base

Promote skills and research

- Promote skills through effective partnerships between universities, geological surveys and industry and promote more awareness
- Promote focussed research on innovative exploration and extraction technologies, recycling, materials substitution and resource efficiency.

Annex IV. Strategic options – a detailed description

A. Recruiting workers from other sectors
A possible solution to meet skill needs is to recruit workers from other sectors, which have and can provide the skills and knowledge needs of the sector and more specifically the firm. Whether or not this is a desirable option depends, amongst others, on the job function under consideration. For managers of large corporations it is quite usual to bring their general know-how to bear in different sectors. Also for business professionals (e.g. financial analysts, software engineers) sector specificities are of lesser importance. Sector mobility of low skilled workers is much more limited than the mobility of higher educated employees. The lesser the grade of sector specialisation of the occupational profile, the easier employees are able to change between sectors. In other cases recruiting workers from other sectors will need training of sector specific skills. In some cases it will also be possible for highly specialised workers to change sectors.

B. Recruiting workers from other Member States
Recruiting workers from other Member States could be in some cases a possibility to overcome skills problems. However, owing to language, cultural and other problems, including certain entrance barriers left to the Member States, mobility within the European Union is still underdeveloped. Border regions are attracting workers from other countries mainly because of wage advantages and in this way can succeed in solving their skills shortages and gaps. However, regions that face such outward migration (e.g. Poland, East Germany, parts of Austria, Hungary, Czech Republic, Slovenia, Bulgaria) at the same time face serious problems in meeting their labour market demands. Some have responded by recruiting workers from non-Member States. Even if this might appear a temporary problem, from a longer term perspective, such developments could have serious consequences for the growth of the regional economy – in what might be termed a 'skills drain' (cf. 'brain drain").

C. Recruiting workers from non-Member States
Recruiting workers from non-Member States is not a zero-sum game for the European economy. Yet this strategic choice is as limited in its overall impact as the strategic choice that proposes to recruit workers from other Member States. On top of this, such recruitment is much more difficult that recruitment from within the EU. In all Member States significant barriers for entering the labour market for workers from outside the EU exist, even for temporary workers. To increase the influx of these workers by, e.g. increasing the immigration quota several political hurdles have to be mastered. Action can be taken here at Member State as well as at EU level, the recent 'blue card' proposal and negotiations serving as an example.

D. Recruiting unemployed workers with or without training
Recruiting unemployed workers without training is a strategic option, especially in case of skill shortages if there are not enough skilled workers to meet the employers demand). This option should in these cases be combined with adequate training. Unemployed workers might have various placement handicaps, especially skills deficits and poor levels of basic qualifications. Low educated groups are still representing the majority of the unemployed labour force, but also highly skilled workers like engineers could be threatened by unemployment.

E. Recruiting young people coming from the education system, with or without re-training
This strategic choice is always a possibility to overcome skill shortages as well as skill gaps. But demographic change should be taken into account too. While in the next few years, until around 2015, there will be a continuous inflow of students entering the labour market, a significant reduction is expected in 2020. In some EU regions there is already a need for young qualified and skilled workers and apprentices. Even where sectors may pay relatively high wages and offer stable carrier prospects, it is not easy to attract enough labour in critical occupational functions. While in the last years labour in business and finance professionals as well as administrative staff and customer services could be attracted the situation in technical occupations (engineers/technicians, construction workers, plant operators) is still critical. Hence, the recruiting of young people can only be successful, if this measure is supported with the other strategic options such as "Improving the image of the sector" and "Stronger cooperation within the industry". To be more precise, a stronger cooperation between schools, university, training organisations, career managers on the one hand and the industry on the other is needed. The principal aim should be to overcome the mismatch of requirements and wishes of individuals on the one hand and the economy on the other.

F. Training employed workers
In some cases training and re-training could also constitute a strategic choice to meet skill demands. In this case, the employee will be trained for a new working place or task. In general, re-training ends with a formal graduation or certificate. Re-training is an option if the work place or the occupational function is not needed any more. But re-training is only one option. Further education or further training, refresher training and updating courses, or advanced vocational qualification to adapt the workforce to emergent skills needs are also options, which should be taken into account. Re-training or further training of employees can encompass all levels of skills. Training and qualification could be done in-house and on the job as well as by an external education institution. It is more likely that less fundamental variations of up-skilling or re-training will be a strategic choice because re-training has to be regarded as a long term and quite expensive measure compared to the other vocational education forms.

G. Changing the work organisation
Work organisation can be defined in different ways. First, it can be defined as a system of work organisation (e.g. Taylorims, Fordism and Post-Fordism) and second, as a form of division of labour and specialisation. In modern economies productivity is based on the division of labour which by definition implies also a division of skills. There are several instruments of work organisation to react on skill shortages and gaps. Thus, changes in the work organisation can help to overcome skill gaps. In general, work can be reorganised in the following possible ways:

- Group work: A group is a limited number of people who work together over a longer period with a frequent, direct interaction. A group is defined through the differentiation of roles and joint values. Groups are able to produce better results than single persons due to the combination of different competencies and experiences, the reduction of wrong decisions, stronger work motivation, the direct use of information, new insights and creativity and a better acceptance of decisions, just to mention a few of the many advantages. There are several kinds of group work, like project groups, quality groups and learning circles, as well as committees.
- Job rotation: Within this type of work organisation several people change their work places in a planned alteration. Job rotation enhances the overview of the different

production processes, the understanding of different tasks and the feeling for group work. Additionally, monotony and dissatisfaction are reduced.
- Job enlargement: Extension of the scope of work through the combination of several structurally equal or similar tasks. It can produce similar effects as job rotation.
- Job enrichment: Extension of the scope of work through the combination of several structurally different tasks. The scope of decision making and self-control increases, as well as the quality and quantity of work. In general, up skilling of the employee is necessary, but this is also implemented on the job.

Under the influence of new technologies, like information and communication technologies, virtual forms of work organisation, which substitute hierarchies through a horizontal network co-ordination, are also possible. In this sense, mergers and acquisitions as well as project based business collaboration are also available options to change the work organisation. Both measures are strategic possibilities to get access to needed resources or to incorporate new skills. Modern (communication) technology can support the co-ordination and co-operation of labourers working at different places and in combining their respective strengths.

H. Outsourcing and offshoring

In public discussion the terms outsourcing and offshoring are mainly used together, yet it must be emphasised that they describe different technical approaches. While outsourcing means the transfer of management or day-to-day execution of business functions or processes (production, manufacturing, services) to an external service provider, offshoring describes the relocation of business functions or processes from one country to another. Both could be applied as a strategic choice on company level to meet skill needs, by integrating the knowledge, experience and competences of the other firm in the production process.

Outsourcing of personnel as a result of technological change and economic pressure was and still is an ongoing trend. Due to de-regulation and privatisation several tasks and with it skills and competences in the sector were outsourced and in some countries dislocated to other countries to increase labour productivity. Several occupational functions in the production chain have been outsourced nowadays. Skill gaps can be closed by hiring subcontractors with the needed knowledge and competences. If one considers this strategic option to meet skill needs, it has to be taken into account that for subcontracting firms, freelance or contractual workers continuing vocational training often plays a marginal role, because employees are all too often indispensible. One should also bear in mind that freelancers are not available at any time and in unlimited numbers. Outsourcing and offshoring is therefore a limited strategic option to overcome skill gaps. It seems to be more adequate to overcome skill shortages.

I. Changing vocational education

Changing vocational education has a long-term effect. It must be taken into account that changes will have a substantial impact in quality and quantity starting at the earliest within three years time after the changes. The process of changing initial vocational education in content or in structure takes itself several years. The process from defining the needs and problems to the implementation of a new curriculum involves several stakeholders from different expert levels like companies, social partner organisations, training institutes as well as representatives of national and regional education administration. These bargaining processes could take several years and are dependent of the VET-system of the European Member State. Hence, this strategic choice will only be drawn if major structural changes are expected.

Despite these facts, possible changes can be seen in a stronger modularisation of curricula of initial vocational training as well as in building up or strengthening interplant and interregional training infrastructure. The first option could in the long run help to overcome

identified skill needs in a sound, flexible and a relatively quick way. The second option is amongst others a possibility to provide the latest high-value equipment for training quickly by sharing resources of several partners.

J. Designing and offering new courses (continuing vocational education and training)
Once it is clear that the current content of vocational training is not up to date and therefore does not address the demands, the development of new courses for continuing vocational education and training could be a strategic option with a short term impact (see also *M. Stronger cooperation between stakeholders).*

K. Providing information about jobs and (emerging) skills
There is still a lack of transparency concerning current and emerging skill needs and job opportunities in different economic sectors. Information systems on regional, sectoral, national or European level could help to minimise information asymmetries and in that way overcome skill gaps resulting from information deficits. As a consequence, it could prove highly effective in helping students to enter the labour market and find a suitable occupation, just as much as in assisting employees to find new job opportunities based on existing skills or guide them in finding the suitable vocational training course.
Career guidance impacts rather short term. Therefore, it can help to overcome the mismatch between the needs and interest of the individual and those of the prevailing economy. The basic assumption of this strategic choice is that there already exist people who are equipped with the required skills and qualifications, but, due to a lack of information about the labour market possibilities, do not apply for these jobs. Career guidance for students and employees can help to overcome this mismatch. In this respect there can be a clear connection to training. Systems for recognition of prior learning (RPL) can help to determine to what extent people possess necessary competences for a new job. Targeted training can bridge the gap for the failing competences.

L. Improving the image of the sector
Improving the image of the sector could be an easy and suitable measure especially to overcome skill and labour market shortages and attract new employees. Several instruments could be implemented by sector organisations in co-operation with different non sector actors like schools, career management organisations, training organisation, public employment services, and public administration. Instruments could be company visits for pupils, offering internships for pupils and enhanced public relation. Especially in sectors where framework conditions and occupational functions changed fundamentally, due to technological or organisational restructuring or low wage levels, this offers a possibility to overcome stereotypes as much as old fashioned views and to attract more labour. Moreover, this measure does not only provide a chance to overcome stereotypes in relation to the sector but also to some occupational functions. The effect of this strategic option is long-term. In consideration of the apprenticeship system, which can take up five to seven years (if the specialisation of high qualified jobs in the sector is taken into account) until the volume effect is reached, one must arrive at the conclusion that in some occupational functions it has to be initiated right now.

M. Stronger cooperation with the industry

A stronger co-operation between industry and training institutes on a regular basis is one possibility to meet the skill needs in the sector. In some sectors and countries training of employees does not seem to be in line with the industry's emerging needs. New training and teaching solutions are to be developed between the industry, sector representatives, education institutions and research centres, public bodies, etc. Information exchange and a stable cooperation between the relevant stakeholders could improve the matching of training needs and demands. In the long run it will enhance the efficiency of training output, strengthen the quality of training and maximize the individual potential. To build up this kind of cooperation takes time, but in the long run it might well be capable to provide accurate solutions for problems. Networks and partnerships between these stakeholders to forecast skill needs in the sectors also present a long term measure. They could help to define emergent skill needs. While knowledge about the development of skill supply is quite high, the knowledge about the development of skill demand in different sectors is still improvable. These kinds of networks can cooperatively detect the need for action and contribute to the development of recommendation of actions.

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Glossary

Apprenticeship. Systematic, long-term training alternating periods at the workplace and in an educational institution or training centre. The apprentice is contractually linked to the employer and receives remuneration (wage or allowance). The employer assumes responsibility for providing the trainee with training leading to a specific occupation. (Cedefop, 2004)

Competence. Competence refers to the proven ability to use knowledge, skills and personal, social and/ or methodological abilities, in work or study situations and in professional and personal development. In the context of the European Qualifications Framework, competence is described in terms of responsibility and autonomy;

Compulsory education. The minimal legal standards and duration of obligatory schooling. (ILO, 1998)

Concentration index. The concentration index assesses the relative contribution of a specific sector to the national economy compared to a greater entity, such as the EU, thereby correcting for the size of the country. In more general terms, the concentration index is a measure of comparative advantage, with changes over time revealing changes in the production structure of a country. An increase of the concentration index for a sector signifies relatively fast growth of that particular sector in the country concerned compared to the same sector in the EU. How does the concentration index work in practice? A few (hypothetical) examples: if sector x represents a 5% share of the German economy and a 5% share of the EU economy, the concentration index of sector x equals a 100. If sector x represents 5% of the German economy, but 10% of the EU economy, the concentration index of sector x is 50. If the same sector x represents 10% of the German economy and 5% of the EU economy, the concentration index of sector x is 200.

The concentration index concept can be applied using different indicators (variables). In our study we measure the concentration index using employment, value added and trade, in order to make a distinction between the relative performance of countries EU-wide. We distinguish between four country groupings, each signifying a different sector performance over time. If a sector in a country has a strong position (hence showing a concentration index higher than 100) and has experienced a clear index growth over the last years, the sector is defined as winning in that country. If the sector has a strong position, but experienced a decline of the concentration index, we say the sector is losing momentum. If the sector has a weak position, but gained in the past, we say that the sector in that country is upcoming. If the sector has a weak position and experienced a decline of the index, we say that the sector is retreating.

Employability. The degree of adaptability an individual demonstrates in finding and keeping a job, and updating occupational competences. (Cedefop, 2000)

European Credit system for Vocational Education and Training (ECVET). A device in which qualifications are expressed in units of learning outcomes to which credit points are attached, and which is combined with a procedure for validating learning outcomes. The aim of this system is to promote:

mobility of people undertaking training;

accumulation, transfer and validation and recognition of learning outcomes (either formal, non-formal or informal) acquired in different countries;

implementation of lifelong learning;

transparency of qualifications;

mutual trust and cooperation between vocational training and education providers in Europe. (Cedefop)

European Qualification Framework for life-long learning (EQF). A reference tool for the description and comparison of qualifi cation levels in qualifi cations systems developed at national, international or sectoral level. (Cedefop)

Full-time Employment. Traditionally means a 'regular job'. Work that is about eight hours a day, five days a week and forty-eight weeks of the year with four weeks paid leave.

Informal learning. Learning resulting from daily activities related to work, family or leisure. It is not organised or structured in terms of objectives, time or learning support. Informal learning is in most cases unintentional from the learner's perspective. (Cedefop, 2008)

Interdisciplinary (multidisciplinary). Interdisciplinary refers to research or study that integrates concepts from different disciplines resulting in a synthesised or co-ordinated coherent whole. New disciplines have arisen as a result of such syntheses. For instance, quantum information processing amalgamates elements of quantum physics and computer science. Bioinformatics combines molecular biology with computer science. An interdisciplinary team is a team of people with training in different fields. Interdisciplinary teams are common in complex environments such as health care.

Job mobility. Any change of job, regardless of where the new job is located.

Knowledge. Knowledge refers to the outcome of the accumulation of information through learning. Knowledge is the body of facts, principles, theories and practices that is related to a field of work or study. In the context of the European Qualifications Framework, knowledge is described as theoretical and/or factual.

Knowledge society. A society whose processes and practices are based on the production, distribution and use of knowledge. (Cedefop, 2008)

Learning outcomes. Learning outcomes refer to statements of what a learner knows, understands and is able to do on completion of a learning process, which are defined in terms of knowledge, skills and competence.

Lifelong learning. All learning activity undertaken throughout life, with the aim of improving knowledge, skills/competences and/or qualifications for personal, social and/or professional reasons. (Cedefop, 2008)

Low, medium, high educated. See also under qualifications. The Labour Force Survey (LFS) collects data for a number of characteristics of employees, one being the level of education of an employee. The LFS is is based on the ISCED 1997 classification (International Standard Classification of Education).

Low-educated encloses all levels up to the compulsory education (ISCED 1+2). ISCED 1: primary education or first stage of basic education. ISCED 2: lower secondary education or second stage of basic education.

Medium-educated comprises all the post compulsory education not tertiary (ISCED 3+4). ISCED 3: (upper) secondary education. ISCED 4: post-secondary non tertiary education

High-educated comprises all tertiary education including university education (ISCED 5+6). ISCED 5: first stage of tertiary education). ISCED 6: second stage of tertiary education (leading to an advanced research qualification).

Low, medium, high skilled. In general this classification refers to the skills required for a specific occupation that an employee currently holds. In existing taxonomies skills levels are usually proxied by educational attainment (see low, medium, high educated).

Mobility, see job mobility.

Multi-skilling. Multi-skilling refers to training an employee to cover a range of different jobs in one workplace. A multiskilled worker is an individual who possesses or acquires a range of skills and knowledge and applies them to work tasks that may fall outside the traditional boundaries of his or her original training. This does not necessarily mean that a worker obtains or possesses high-level skills in multiple technology areas. However, the worker can be an effective and productive contributor to the work output of several traditional training disciplines.

Multi-tasking. The ability of a person to perform more than one task at the same time.

Profession. An occupation which requires knowledge gained through academic study, such as law, medicine or teaching.

Qualification. Qualification refers to a formal outcome of an assessment and validation process which is obtained hen a competent body determines that an individual has achieved learning outcomes to given standards.

Qualifications, Comparability of -. The extent to which it is possible to establish equivalence between the level and content of qualifications (certificates, diplomas or titles) at sectoral, regional, national or international levels. (Cedefop, 2000)

Qualification, level of -. Low: at most lower secondary (ISCED 0-2); medium: upper secondary (ISCED 3-4); high: Tertiary (ISCED 5-6).

Qualification framework. An instrument for the development and classification of qualifications (e.g. at national or sectoral level) according to a set of criteria (e.g. using descriptors) applicable to specified levels of learning outcomes. (OECD, 2007)

Retraining. Training enabling individuals to acquire new skills giving access either to a new occupation or to new professional activities. (Cedefop, 2004)

Revealed Comparative Advantage (RCA). Relative comparative advantage compares the relative contribution of sector x to the comparative advantage of the national economy with other sectors. It is calculated as follows:

RCA = tanh (ln ((Exports S / Imports S) / (Exports C / Imports C))) x 100

Interpretation: 0 = the comparative advantage of sector x equals the average of the comparative advantage of the entire national economy. Near -100: the sector contributes nothing to the comparative advantage of that country. Near + 100: the sector contributes strongly to the comparative advantage of the country.

The use and logic of the country groupings winning, losing momentum, upcoming and retreating in combination with revealed comparative advantage is similar to the concentration index (see above).

Skills. Skills refer to the ability to apply knowledge and use know-how to complete tasks and solve problems. In the context of the European Qualifications Framework, skills are described as cognitive (involving the use of logical, intuitive and creative thinking) or practical (involving manual dexterity and the use of methods, materials, tools and instruments).

Skills gaps. Skills gaps arise where an employee does not fully meet the skills requirements for a specific job function but is nevertheless hired. This skills gap needs to be closed through training. Skills gaps can arise where new entrants to the labour market are hired and although apparently trained and qualified for occupations still lack some of the skills required.

Skills needs, emergent -. Emergent skills needs are defined in this study as the change in skills that is needed to adequately fulfil a certain job function in the future. Addressing emergent skills is needed in order to avoid skills shortages and/or skills gaps in the future.

Skills shortages. Skills shortages exist where there is a genuine lack of adequately skilled individuals available in the accessible labour market. A skill shortage arises when an employer has a vacancy that is hard-to-fill because applicants lack the necessary skills, qualifications or experience.

Tertiary education. Tertiary education refers, in most settings to non-compulsory education provided via a specialist institution once secondary schooling is completed, usually labelled as a college, polytechnic or university (in English) with variants of these in other languages. Tertiary education may be delivered virtually or at a distance.

Trade balance. Exports minus imports.

Training. The development of skills or knowledge through instruction or practice; a kind of vocational learning such as an apprenticeship or traineeship which includes both formal education and on-the-job experience.

Unskilled work. Work which lacks specialist training or ability and generally involves simple manual operations which can be learned in a short time.

Up-skilling. Short-term targeted training typically provided following initial education or training, and aimed at supplementing, improving or updating knowledge, skills and/or competences acquired during previous training. (Cedefop, 2004)

Vocational Education and Training (VET). Education and training which aims to equip people with skills and competences that can be used on the labour market. (adapted from ETF, 1997).